APPENDIX 6: WORKSHOP MATERIALS AND SYNTHESES

Table of Contents

Steering Committee Kickoff

Date(s)

5.26.10 and 7.1.2010

Location

Gould Hall. UW Seattle.

Objective

Introduction for Steering Committee members, to project and each other. Presentation on the Basin, Scenario Planning and project overview. Discussion on effective project deliverables.

Attendance

Steering Committee (see Appendix 1).

Agenda

- Presentation on the Snohomish Basin, scenario planning and the SBS project.
- Roundtable discussion of perspectives and directives.

Materials

(see presentation slides pages A6-3-10)

Synthesis

Steering Committee Directives

1. Informed criteria to understand additional questions to ask in order to decide among potential strategies
2. Rigorous tests to better identify opportunities and challenges otherwise potentially unforeseen.
3. Help prioritize actions over the short term that are effective across multiple conditions.
4. Think about decisions through the lens of alternative actors
5. Integrate multiple and diverse expert perspectives on potential drivers of change.
6. Build on existing work that has been done in the basin and region.
7. Articulate the scenarios by contrasting future baselines to current conditions, onto which alternative strategies can be overlaid
8. Validate ideas expressed in project deliverable with scientific and professional work

Snohomish 2060 Scenarios
Kickoff Meeting

Steering Committee
Wednesday, May 26th 2010

introductions

project objectives

- Identify critical **factors** driving the future urban growth and associated environmental change in the Basin.
- Systematically assess the impacts of future scenarios on essential **ecosystem services** focusing on *biodiversity*, *water*, and *carbon*.
- Collaborate between a diversity of **experts** and stakeholders to identify opportunities and develop a set of robust strategies to maintain human and ecosystem wellbeing under alternative futures.

meeting objectives

- get acquainted
- introduce project and approach
- learn how to tailor the process and products to better suit your needs.

agenda

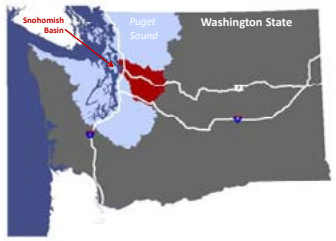
- 8:30 – 9:00 Welcome
- 9:00-10:00 Presentation
- 10:00-11:00 Roundtable Discussion
- 11:00-12:00 Student Presentations
- 12:00 - 1:00 Lunch and Next Steps

presentation outline

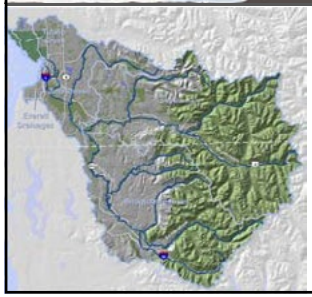
- **SB** Today and Tomorrow
- **SP** What and Why
- **SBS 2060** Intentions and Input

SNOHOMISH BASIN
today and tomorrow

Snohomish Basin

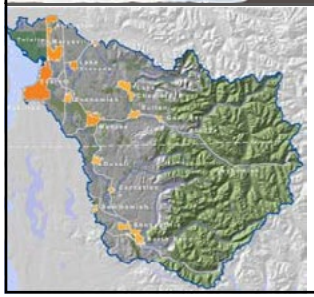


WRIA 7



- **Water Resource Inventory Area 7:** Snoqualmie, Skykomish and Snohomish Watersheds and the Tulalip and Everett Drainages

urban development

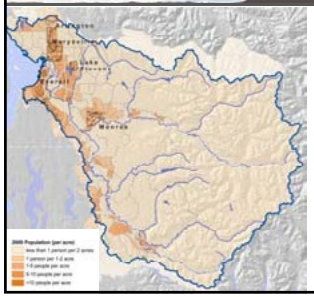


- 1,190,000 acres
- Major urban centers include Everett, Marysville, Arlington, Monroe and Lake Stevens.

urban development

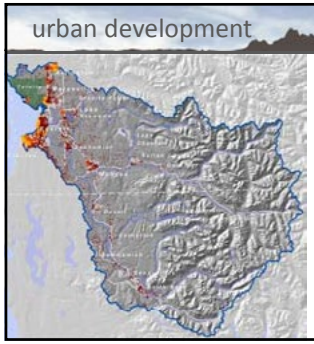
- 53,00 acres of urbanized lands
- 4.5% of Basin
- Based on 2007 land cover data including cells with more than 50% area in impervious surfaces.

urban development



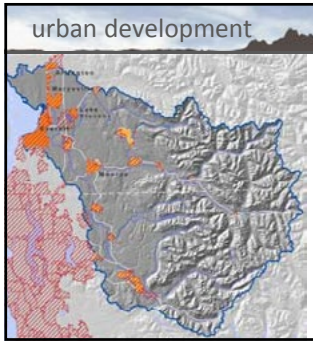
- 50% lives in urbanized areas
- 446,476 population (2009)
- 22% increase since 2000 and 1,000%+ increase since 1900(36,000)

urban development



- 170,000 employees
- Manufacturing medical and hospitality.
- ~50% of the people who live in the Basin work in the Basin.

urban development



- 20% of the Urban Growth Area extends outside current urban areas.

urban development

1900

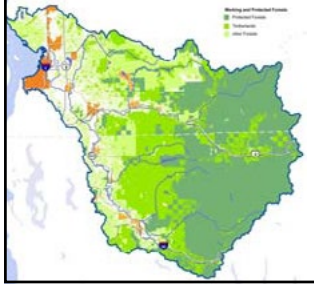
urban development

2000

forestlands

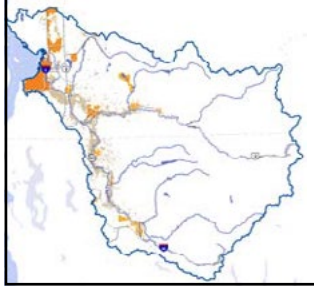
- The Basin boasts over 770,000 acres of forestlands accounting for 60% of the total land in the Basin.

forestlands



- ~50% of those forests are in active timberland
- ~40% are protected
- and 10% are under private land ownership and are not being managed for timber.

agriculture

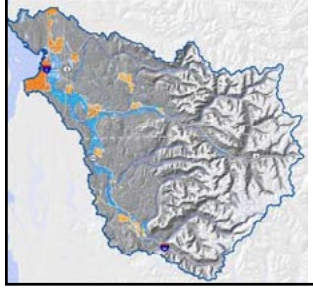


- Basin supports 46,000 acres of active farmland.

agriculture

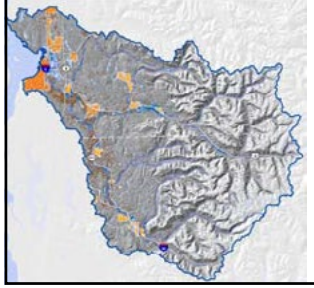
- Topographic relief from sea level to 8,000 feet
- Flows east to west and into Puget Sound
- Along the Snohomish, Snoqualmie, and Skykomish,

agriculture



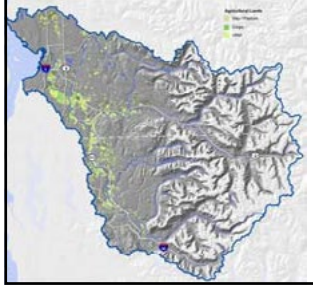
- Heavy winter precipitation and early spring snowmelt can lead to flooding in the lower valley of the Basin.

agriculture



- Floodplains support good soil for farming.

agriculture



- aglands support a diversity of crops and pasture lands.
- and a diversity of farming techniques and property sizes.

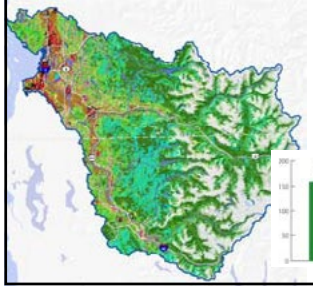
drinking water

- The Tolt and Spada Reservoirs each serve ~500,000 residents in King and Snohomish County respectively.

habitat

- The Basin supports a diversity of wildlife and flora through a network of unique habitats and corridors.

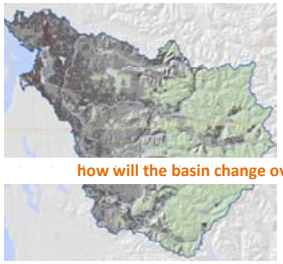
Carbon Storage



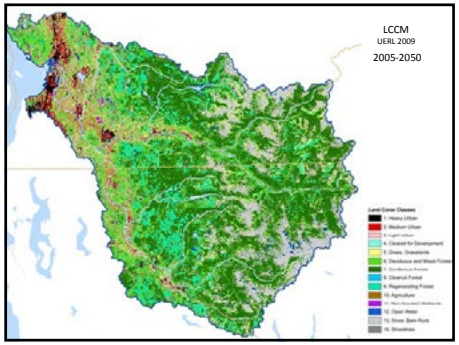
- 1.5 million tonnes of carbon are stored within the Basin's forests.

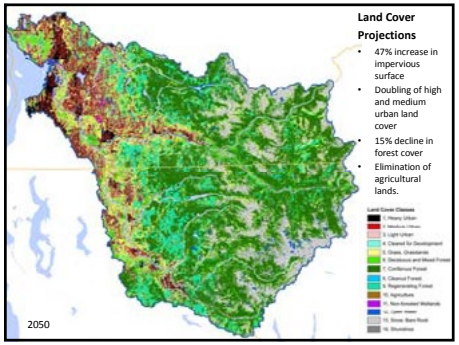
The Basin's **Future**

The Basin's **Future**

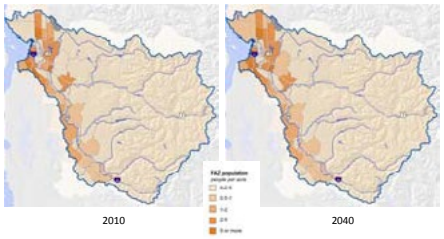


how will the basin change over the next 50 years.

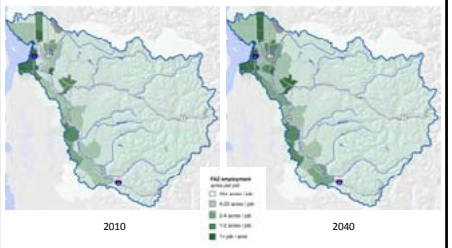




Growth Factors



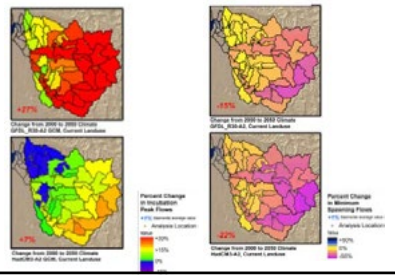
Growth Factors



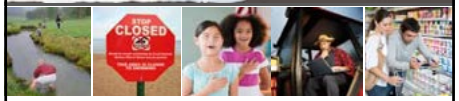
ecosystem flows

- what will grow here?
- how will forests fare?
- will we further fragment habitat?
- how will our plant communities and wildlife endure changes?
- what will be the levels of pollution?

climate change



socio-political



- will our social values change?
- how will we value our future?
- what will change about how we see the world around us?
- how will it influence our decision making?
- how will we govern ourselves?
- what types of partnerships will we create?

investments

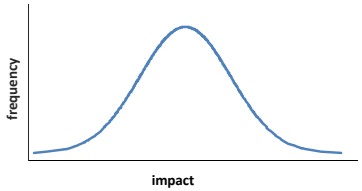
- what will be our **quality of life** in fifty years?
- how will we invest regional and local funds?
  - in social services such as education and public health?
  - in regional infrastructure and other innovations?
  - in ecosystem restoration?
- will we invest on a regional or local scale? will we integrate?
- how much money will be available?
  - who will have the money?
  - how will we try to solve problems?
  - what will be the role of citizens? public agencies? private entities?

SCENARIO PLANNING
what and why

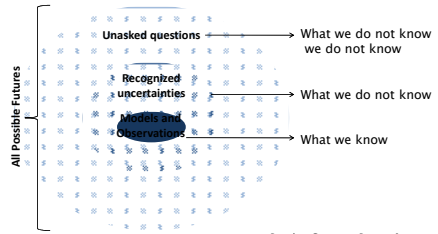
decision making

- What is the difference between scenarios, visions and predictive models?
  - **Predictive models** help us determine the probable.
    - *They are generally based on empirical data*
  - **Visions** help us determine what we want to have happen.
    - *They are generally based on community goals.*
  - **Scenarios** help us direct our strategy to the most relevant uncertainty dimensions.
    - *They characterize all plausible futures.*

future conditions

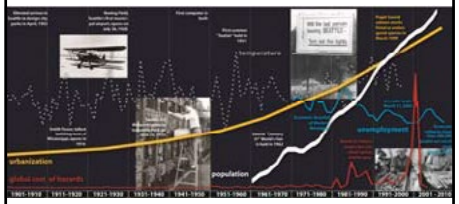


what do we know?



Based on Carpenter, Bennett & Peterson, 2006.

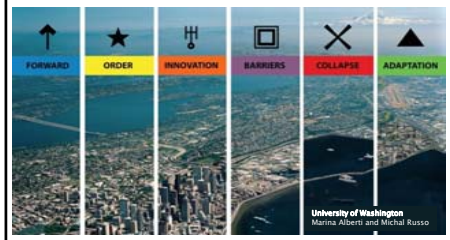
future surprises



what are scenarios?

- Scenarios are **hypotheses** of alternative futures designed to ***highlight the risks and opportunities*** involved in strategic issues and assess strategic decisions.
- Instead of focusing on a single prediction extrapolated from past trends, scenarios focus on uncertain drivers and **expand the assumptions** of predictive models to illuminate otherwise unforeseen **interactions between individual trajectories**.
- Scenarios are **illustrative** accounts of multiple futures that direct our attention towards alternative outlooks that contain the most **relevant uncertainty dimensions**.
- Scenarios help us ask: If the future turns out **differently** than originally anticipated, will our ***strategy still work***?

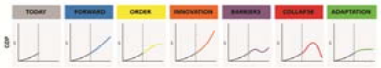
Puget Sound Scenarios

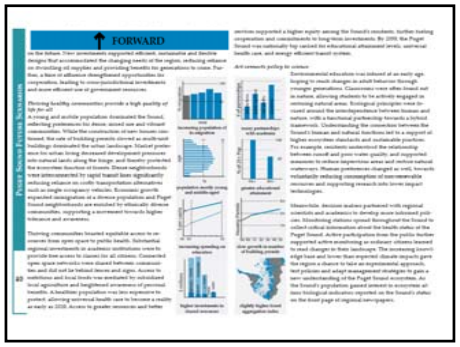


key drivers

supporting drivers

- Supporting drivers hypothesize consequent implications for the region's:
  - Demographics
  - Development Patterns
  - Economics
  - Governance
  - Knowledge and Information
  - Natural Hazards
  - Public Health
  - Technology and Infrastructure





benefits of SP

1. Provide insight into **drivers** of change
2. Reveal implications of potential future **trajectories**
3. Challenge our **assumptions** about the future
4. Take into account **uncertainty** and surprise
5. Synthesize **complex** information
6. Incorporate differences among **stakeholders**
7. Illuminate unforeseen **risks** and **opportunities**
8. Assess **tradeoffs** among alternative strategies

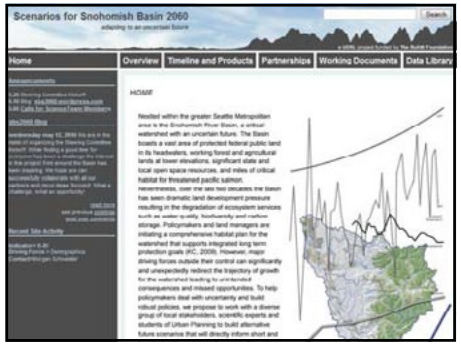
SBS2060

SNOHOMISH BASIN SCENARIOS 2060

intentions and input

focal issue

- How can we maintain Ecosystem Services (*Carbon, Water and Biodiversity*) in Snohomish Basin [WRIA 7] over the next 50 years?



Facilitating organizations working in the Basin?

HOW CAN WE HELP YOU?

- *bring together people and data*
- *integrate diverse assessments*
- *reveal questions for testing*
- *inform new strategy formation*

Facilitating organizations working in the Basin?

HOW CAN WE HELP YOU?

roundtable

discussion

- who you are?
- what is your focus and expertise in the Basin?
- how do you see the future of the basin?
- how could this project benefit your work?
- suggest one opportunity and one pitfall

Key Drivers Focus Group Meetings

Date(s)

August 2010

Location

Gould Hall. UW Seattle.

Objective

Each interview and focus group meeting included 5 overall objectives: This interview will take between 1-2 hours and has 5 overall objectives:

1. To confirm expertise to be included in the Study's Science Team Partner Bios webpage

2. To identify key elements, agents and drivers impacting the Basin's future

3. To develop a conceptual map of drivers and their relationship to ecosystem services

4. To collect data

5. To identify additional Science Team partners

Attendance

Science Team members (see Appendix 1). Focus groups included agriculture, biological scientists, economics, ecosystem restoration, governance, growth management, human perceptions and behavior, infrastrucure, physical scientists, real estate, recreation and public lands, risk management, social services, timber and forestlands, tribes, and water and energy.

Agenda

Interviews were 1 hour and focus groups were 2 hour long. They inlcuded a series of questions and a small conceptual model exercise. See Interview Instrument below).

Materials

Interview Instrument:

There are two parts to this interview. In the first part, we will do a small exercise. In the second part, we'll ask questions related to your area of expertise.

1. Can you describe your work and its relationship, if any, to the Snohomish Basin?

Part I: Future of the Basin

2. Think about the Puget Sound fifty years ago (1960), what were the fundamental differences between life today and life then?

3. Think about Puget Sound fifty years from now (2060), what do you believe will be the fundamental differences between life today and life then?

4. Think about the Snohomish River Basin fifty years from now (2060), what do you believe will be the fundamental differences between life today and life then?

What are the key elements of change (drivers) that will characterize the Basin's social-ecological system in 2060? (Moderator: write down their key elements as keywords and place in front of them)

Group the keywords into categories or subgroups. Name each group.

Draw arrows between the groups to specify networks and feedback.

Walk us through your final model. Are you satisfied with it? What, if anything do you believe is missing?

Part II: Data Collection

10. In the beginning of this interview you mentioned that your expertise and its relationship to the Basin. Choose a keyword, group or connection that you feel best reflects this area of expertise?

How do you define ___ (insert keyword, group, or connection)?

Describe its relevance to the Basin.

With reference to regional, basin or national studies, projects and data, describe its status and trend.

Which indicator(s) or metric(s) best describes its status?

11. Can you recommend 3-5 experts that we should conduct this interview with that may have a different perspective from you?

12. Is there anything else you would like to add?

Consent Form

(see pages A6-3-10)

CONSENT FORM

RESEARCHER'S STATEMENT

We are asking you to be in a research study. The purpose of this consent form is to give you the information you will need to help you decide whether to be in the study or not. Please read the form carefully. You may ask questions about the purpose of the research, what we would ask you to do, the possible risks and benefits, your rights as a volunteer, and anything else about the research or this form that is not clear. When we have answered all your questions, you can decide if you want to be in the study or not. You may refuse to participate and you are free to withdraw from this study at any time without penalty or loss of benefits to which you are otherwise entitled. This process is called "informed consent." We will give you a copy of this form for your records.

PURPOSE OF STUDY

How we think about the future has substantial consequences on how we define the problems and search for effective solutions. To help policymakers deal with uncertainty and build robust policies, we propose an innovative approach that links scenario planning and predictive modeling to identify and implement adaptive strategies to protect the long term ecosystem services of the Snohomish River Basin *(see attached map for Study boundary).* We will collaborate through partnership with managers, experts, stakeholders working in and around the Basin, and University of Washington planning students to implement the development of the scenarios. The final scenarios will represent plausible futures helping the community build a shared vision that takes into account long term uncertainties while highlighting priority actions. For more on this project, please visit our website at: www.urbaneco.washington.edu/sbs

Three **objectives** guide the development of this project:

1. Identify critical factors driving the future urban growth and associated environmental change in the Basin.
2. Systematically assess the impacts of future scenarios on essential ecosystem services focusing on biodiversity, water, and carbon.
3. Collaborate with a diversity of experts and stakeholders to identify opportunities to maintain human and ecosystem wellbeing under alternative futures.

BENEFITS OF THE STUDY

The Scenarios for the Snohomish River Basin will help shape robust policies by providing a set of plausible future conditions against which to develop strategies to achieve desired goals. Anticipating changing conditions will allow decision makers to be proactive and flexible.

1. Identify priority actions in the short term and a diverse portfolio of actions that can adapt to critical signals of change in the long term.
2. Quantified impacts to ecosystem services through predictive models providing policy makers and managers with critical data to push forward financial and political backing of specific policies.
3. Illustrative alternative futures that enable decision makers to communicate the basis of policy direction with a larger constituency and garner much needed awareness and ownership of the strategic framework within the local community.
4. Future Basin collaboration through partnerships of various committee members and experts involved in this project.

SCIENCE TEAM PARTNERSHIP

Process and Time Commitments

As a member of our Science Team we look forward to your on-going participation over this two-year project. While we have made all strides to minimize our partner's time commitment, we believe that interdisciplinary engagement and transparent feedback are essential to the credibility of our final product. Over the duration of the Study you will be invited:

- An individual or focus team interview (July, 2010)
- Half-day Conceptual Model workshop (August 2010)
- Full-day Scenario Logics workshop (November 2010)

In addition, we will request your confidential online feedback on drafts of our four project deliverables:

- Preliminary Assessment Report (Sept 2010)
- Scenario Narratives (February 2011)
- Future Ecosystem Services Assessment (July 2011)
- Final Report (December 2011)

For details of the workshops and project deliverables please visit our website at www.urbaneco.washington.edu/sbs.

Objective of Interview

This interview will take between 1-2 hours and has 5 overall objectives:

1. To confirm your expertise to be included in the Study's Science Team Partner Bios webpage
2. To identify key elements, agents and drivers impacting the Basin's future
3. To develop a conceptual map of drivers and their relationship to ecosystem services
4. To collect data and
5. To identify additional Science Team partners

Initial Interview Process

The information gathered in this interview will be used in conjunction with other expert interviews to identify a selection of driving forces and ecosystem services and develop a conceptual model of their connections. We will send you a digital transcript of this interview within 48 hours for your verification. Prior to the August Conceptual Model workshop working documents will be posted on our website summarizing material discussed within these Science Team interviews. Information gathered during the initial interview and Conceptual Model Workshop will directly inform the development of the Preliminary Assessment Report.

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Tracy Fuentes
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Printed name of study staff obtaining consent | Signature | Date

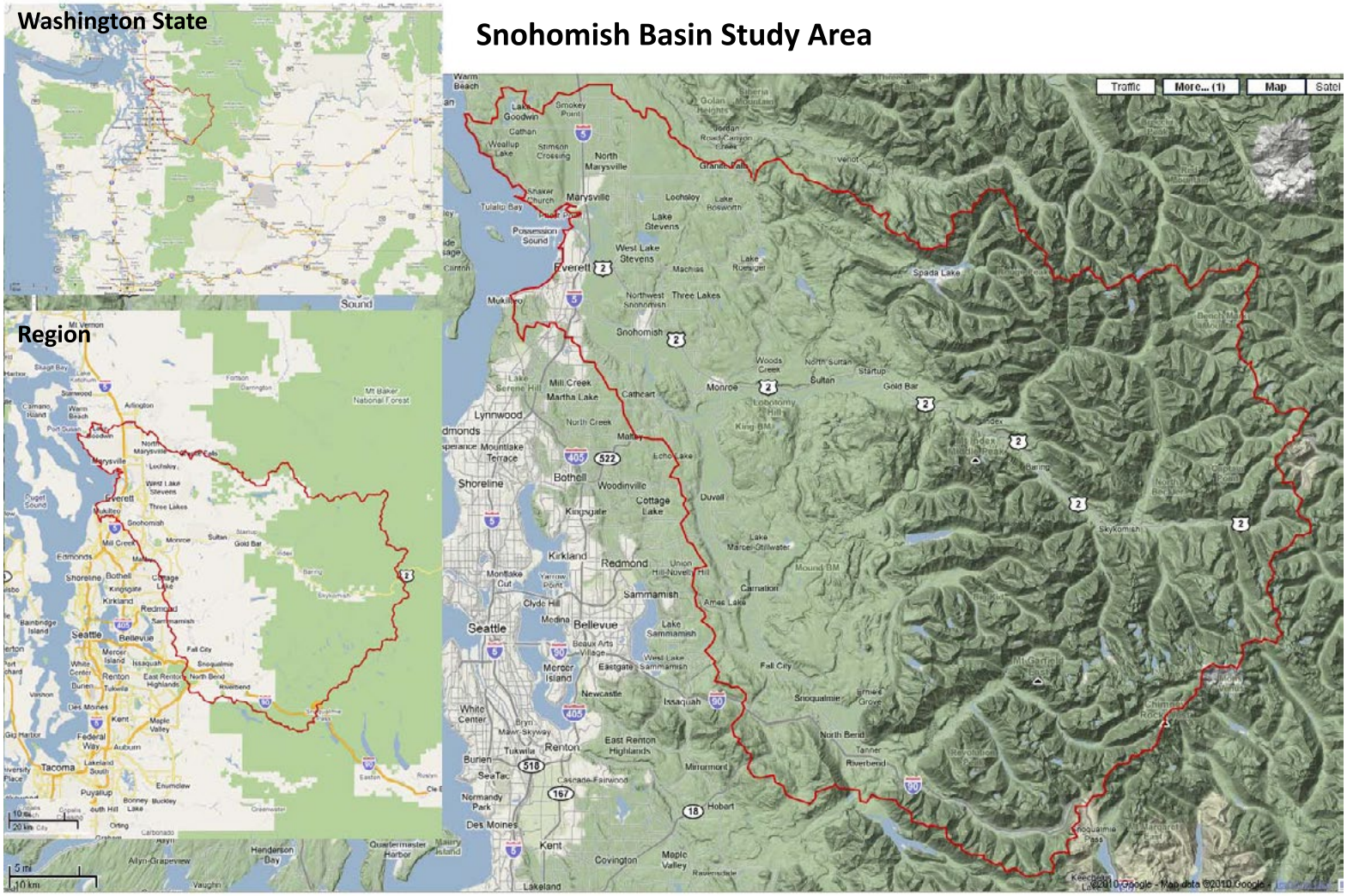
SUBJECT'S STATEMENT

This study has been explained to me. I volunteer to take part in this research. I have had a chance to ask questions. If I have questions later about the research, I can ask one of the researchers listed above. If I have questions about my rights as a research subject, I can call the Human Subjects Division at (206) 543-0098. I give permission to include my name, title, affiliation and brief bio as a part of the study's Science Team and shared on the study's public website: www.urbaneco.washington.edu/sbs. I give permission to include my interview statement as research material within this project and its final reports. I understand that my name and affiliation will not be linked to any written comment without my prior approval.

I will receive a copy of this consent form.

Printed name of subject | Signature of subject | Date

Snohomish Basin Study Area



Synthesis

In the Summer of 2010 the UERL interviewed 78 people who identfied 3,500 keywords and drafted 49 conceptual models. The synthesis of the focus groups was directly utilized to support the conceptual model workshop (see next section) including a

> a synthesized list of keywords used by the science team to develop a shared conceptual model. (see page A6.14 for list of common keywords and group titles).

> a synthesis of problem definition and common themes (page A6.15)

> images of alternative conceptual models (pages A6.16-25)

> 3 overarching conceptual models representative of similaries and differences between focus group models. (pages A6.26)

Interviews also yielded definitions for drivers and themes (integrated in driving force working papers included under synthesis of conceptual model workshop), a list of data sets, projects and indicators (integrated into Appendix 3 Past and Future Trends of Key Driving Forces and Data Library Items available online - http://www.urbaneco.washington.edu/sbs/data-all.php), and a list of potential experts to interview and integrate into the project (included in Appendix 1: Science Team).

List of Common Focus Group Keywords (most common group titles in* bold*)

Access to information
Actors
Adaptability
Aging
Agriculture
Analysis
Annexation
Assessment
Awareness
Behavior
Benefits
Biodiversity
Capacity
Carbon neutrality
Climate Change
Communication
Community
Competition
Conflicts
Consumption
Cooperation
Costs
Culture
Dams
Density
Design
Development
Diversity
East / West Distinction
Economy
Ecosystem Health
Ecosystem Services
Education
Energy
Environmental Impacts
Engagement
Equality
Ethnicity
Fish
Flooding
Food
Forests
Forest Management
Forest Products
Funding
Geomorphology
Global Forces
Governance
Ground water
Growth
Habitat
History
Housing
Human Hazards
Human Health
Hydrology
Impacts
Income
Industry
Infrastructure
Institutions
Interdependence
Invasive species
Jurisdiction
Knowledge
Labor
Land cover
Land Use
Legacy / Time
Legal system
Management
Market (demand and supply)
Migration Patterns
Mitigation
Natural Disasters / Hazards
Natural Resources
Ocean processes
Ownership
Pace
Perceptions
Places
Planning
Plants
Politics
Pollution
Population
Preferences
Pressure
Protection / Conservation
Public / Private
Quality
Recreation
Regulation
Risks
Rural character
Scale
Settlement patterns
Snow pack
Social
Social Services
Solutions
Sprawl
Stormwater
Sustainability / Resilience
Taxes
Technology
Thresholds
Timber
Traffic
Transportation
Tribes
Uncertainty
Upland / lowland
Urban Centers
Urbanization
Waste Stream
Water Quality
Water Resources
Water Supply
Wildlife
Willingness

When asked about the past and future of the Basin, Science Team members often revolved around the same theme, but embedded in a different context, or outcome. For example, one expert may describe the GMA as effective, describing how clearly the boundary can be seen with aerial photos but proposes that the boundary doesn't do enough, while another expert may criticize the GMA as creating economic disparities. We focus on the themes as open-ended discussion points as opposed to trying to figure out which expert is right, to guide the development of the scenarios.

Our approach focused heavily on problem definition. What are the critical uncertainties affecting the future of the Basin? What should our scenarios test? What are managers grappling with for long-term strategies?

The following reflects the top ten themes and associated questions heard from our Science Team:

1. Economic competitiveness: Will the quality of life in the Basin bring in more industry or will other nations and lower-barrier regions out-compete us? Will Boeing be around? Does protecting the environment ironically support growth? Might a growing economy benefit the environment?

2. The cost of environmental regulation: Will resource industries survive additional regulations? Who wins the fish or the farmers? What are the tradeoffs and who decides? Is the burden of protection distributed evenly across the public?

3. Timing of climate change: When will the rains fall? Will major change occur soon or closer to the end of the century? Will precipitation fall as rain or snow? Will we see more flooding or drought, or both? Will severe events happen more frequently?

4. Supported demography: Will immigrants be met with equity and adequate service provision? What are the changing needs of the aging population? Will the economic divide widen further?

5. Limits to growth: Do our economic policies assume continuous growth? What is the carrying capacity of the Basin? Can we keep sprawling further? Does the GMA function in curtailing growth? Is there a threshold before natural resources provision plummets?

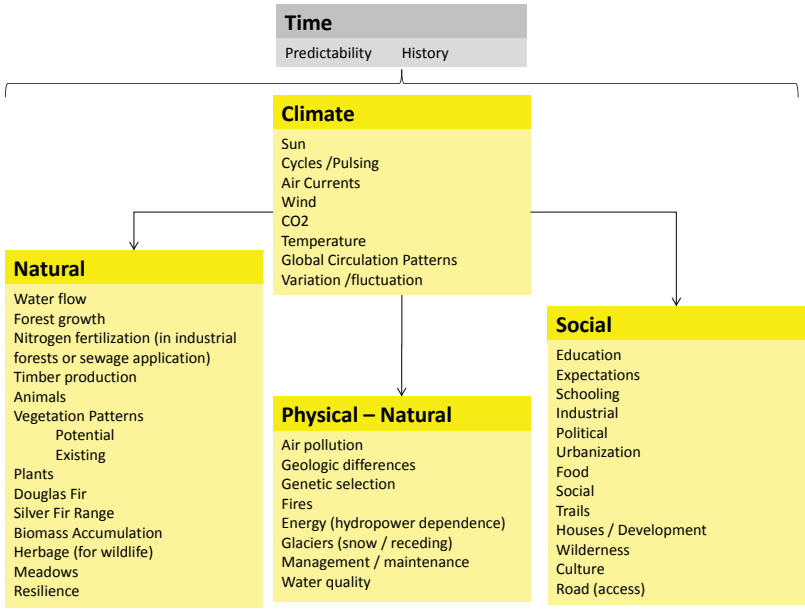
6. Small scale management: Is resource management sustainable at small scales? Do individual hobby farmers and harvesters have the experience, the legitimacy, the long-view to support sustainable land management? Do large scale managers share the ethical perspective as the community? Is small-scale farming economically profitable, and therefore a viable future alternative, or is it supported only by second incomes?

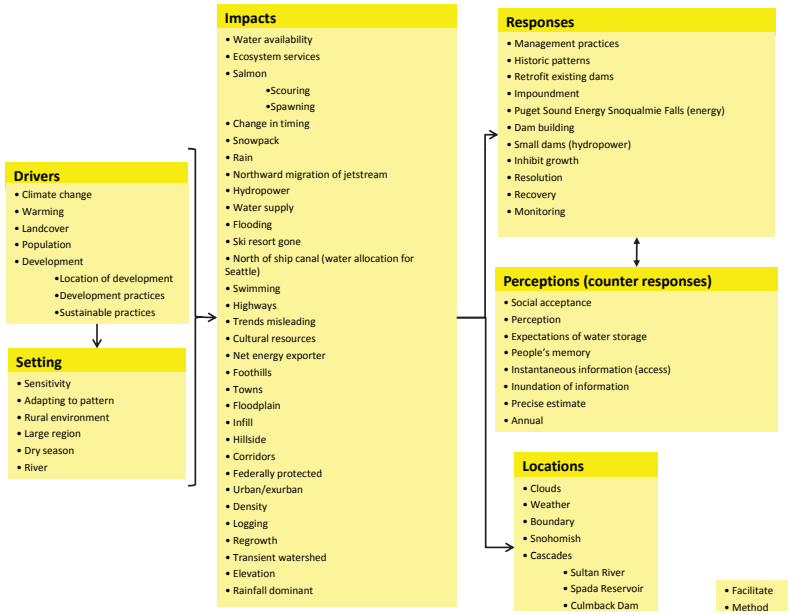
7. Power of innovation: Who will control the Region's innovations? Will solutions stem from public means or private investments? How will that affect the scale of operations? Will we see larger economic disparities? Will the privatization of services affect the inclusion of externalities?

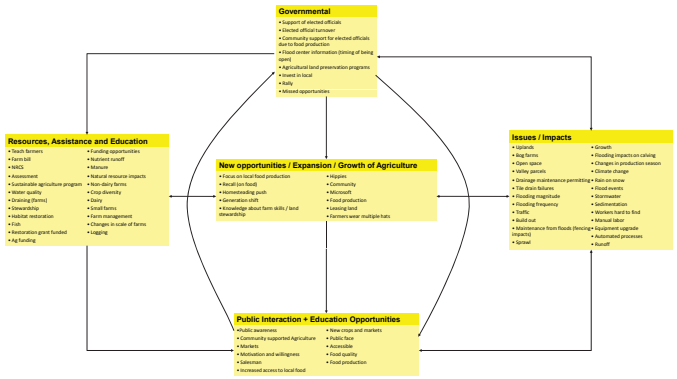
8. County government: Are incorporations too costly? Are they subsidized by the GMA? Will county government still be around in 50 years? Will the county have to bail out failing municipalities?

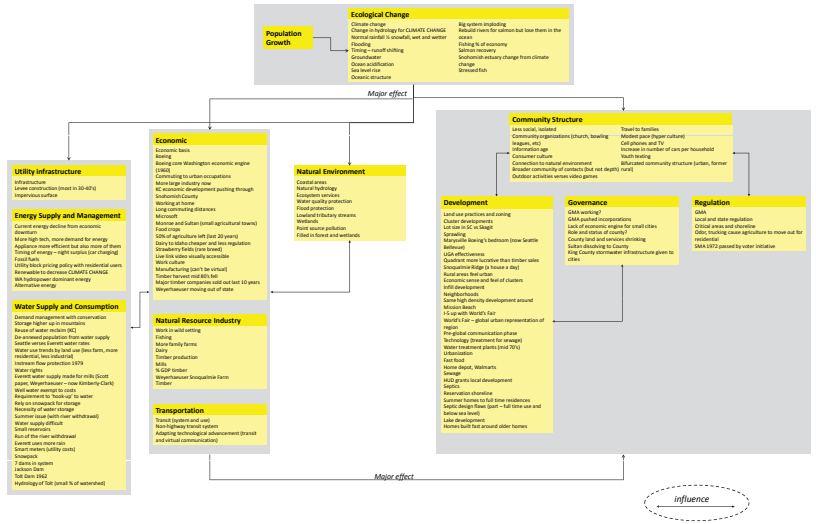
9. Water provision: Will water be abundant in the future? Will snowpack be gone from the Basin? Will we build more reservoirs? Will we have enough water for additional users including a growing population and industries? Will we invest in water-efficient infrastructure? Will precipitation patterns change in terms of timing and magnitude of precipitation?

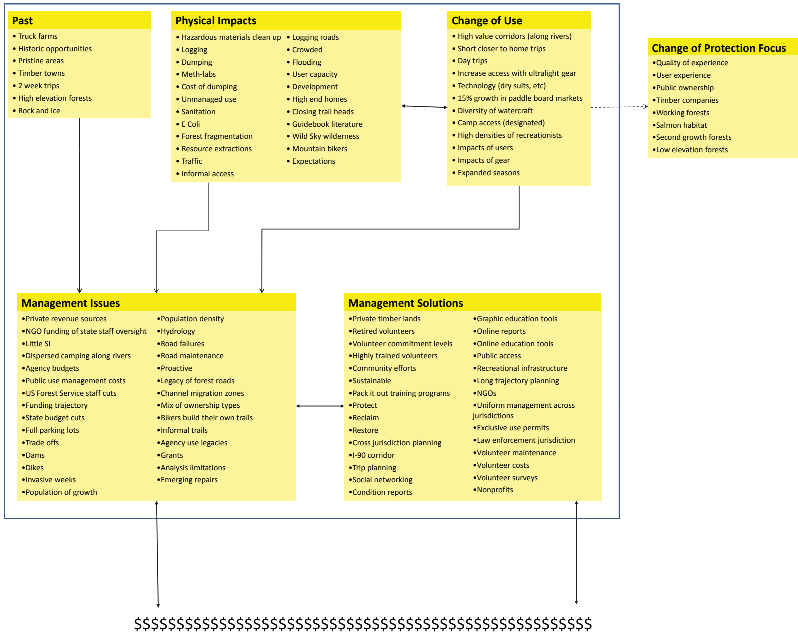
10. Culture shift: Will we change (in time)? Will we learn to be 'good'? Will our heritage (tribal, cultural, natural) survive? Will we listen to scientists? Will we be proactive? Will society's goals be aligned? Will we prioritize the environment? Will we sacrifice for the collective good?


Time
Predictability
History
Climate
Sun
Cycles /Pulsing
Air Currents
Wind
CO2
Temperature
Global Circulation Patterns
Variation /fluctuation
Natural
Water flow
Forest growth
Nitrogen fertilization (in industrial forests or sewage application)
Timber production
Animals
Vegetation Patterns
Potential
Existing
Plants
Douglas Fir
Silver Fir Range
Biomass Accumulation
Herbage (for wildlife)
Meadows
Resilience
Physical – Natural
Air pollution
Geologic differences
Genetic selection
Fires
Energy (hydropower dependence)
Glaciers (snow / receding)
Management / maintenance
Water quality
Social
Education
Expectations
Schooling
Industrial
Political
Urbanization
Food
Social
Trails
Houses / Development
Wilderness
Culture
Road (access)

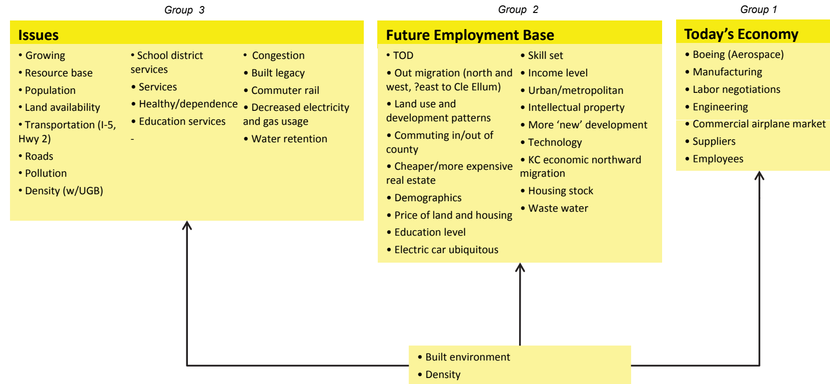

Drivers
• Climate change
• Warming
• Landcover
• Population
• Development
•Location of development
•Development practices
•Sustainable practices
Setting
• Sensitivity
• Adapting to pattern
• Rural environment
• Large region
• Dry season
• River
Impacts
• Water availability
• Ecosystem services
• Salmon
•Scouring
•Spawning
• Change in timing
• Snowpack
• Rain
• Northward migration of jetstream
• Hydropower
• Water supply
• Flooding
• Ski resort gone
• North of ship canal (water allocation for Seattle)
• Swimming
• Highways
• Trends misleading
• Cultural resources
• Net energy exporter
• Foothills
• Towns
• Floodplain
• Infill
• Hillside
• Corridors
• Federally protected
• Urban/exurban
• Density
• Logging
• Regrowth
• Transient watershed
• Elevation
• Rainfall dominant
Responses
• Management practices
• Historic patterns
• Retrofit existing dams
• Impoundment
• Puget Sound Energy Snoqualmie Falls (energy)
• Dam building
• Small dams (hydropower)
• Inhibit growth
• Resolution
• Recovery
• Monitoring
Perceptions (counter responses)
• Social acceptance
• Perception
• Expectations of water storage
• People's memory
• Instantaneous information (access)
• Inundation of information
• Precise estimate
• Annual
Locations
• Clouds
• Weather
• Boundary
• Snohomish
• Cascades
• Sultan River
• Spada Reservoir
• Culmback Dam
• Facilitate
• Method


Governmental
Resources, Assistance and Education
New opportunities / Expansion / Growth of Agriculture
Issues / Impacts
Public Interaction + Education Opportunities

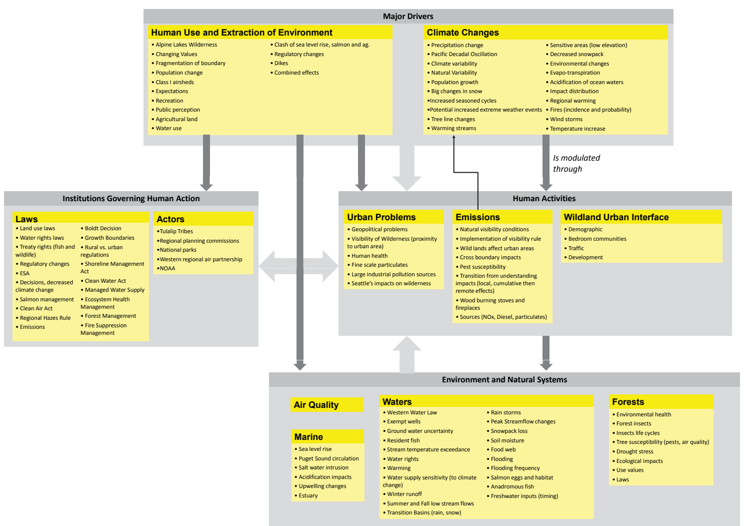

Population Growth
Ecological Change
Major effect
Utility infrastructure
Energy Supply and Management
Water Supply and Consumption
Economic
Natural Resource Industry
Transportation
Natural Environment
Community Structure
Development
Governance
Regulation
Major effect
influence



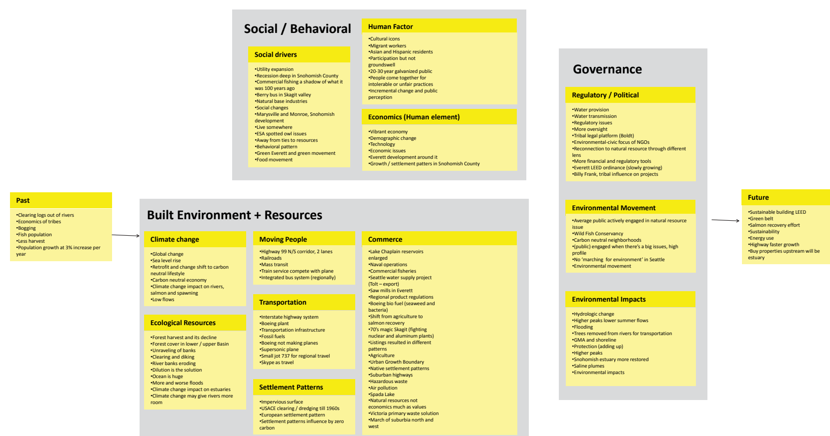
Past
• Truck farms
• Historic opportunities
• Pristine areas
• Timber towns
• 2 week trips
• High elevation forests
• Rock and ice
Physical Impacts
• Hazardous materials clean up
• Logging
• Dumping
• Meth-labs
• Cost of dumping
• Unmanaged use
• Sanitation
• E Coli
• Forest fragmentation
• Resource extractions
• Traffic
• Informal access
• Logging roads
• Crowded
• Flooding
• User capacity
• Development
• High end homes
• Closing trail heads
• Guidebook literature
• Wild Sky wilderness
• Mountain bikers
• Expectations
Change of Use
• High value corridors (along rivers)
• Short closer to home trips
• Day trips
• Increase access with ultralight gear
• Technology (dry suits, etc)
• 15% growth in paddle board markets
• Diversity of watercraft
• Camp access (designated)
• High densities of recreationists
• Impacts of users
• Impacts of gear
• Expanded seasons
Change of Protection Focus
•Quality of experience
•User experience
•Public ownership
•Timber companies
•Working forests
•Salmon habitat
•Second growth forests
•Low elevation forests
Management Issues
•Private revenue sources
•NGO funding of state staff oversight
•Little SI
•Dispersed camping along rivers
•Agency budgets
•Public use management costs
•US Forest Service staff cuts
•Funding trajectory
•State budget cuts
•Full parking lots
•Trade offs
•Dams
•Dikes
•Invasive weeks
•Population of growth
•Population density
•Hydrology
•Road failures
•Road maintenance
•Proactive
•Legacy of forest roads
•Channel migration zones
•Mix of ownership types
•Bikers build their own trails
•Informal trails
•Agency use legacies
•Grants
•Analysis limitations
•Emerging repairs
Management Solutions
•Private timber lands
•Retired volunteers
•Volunteer commitment levels
•Highly trained volunteers
•Community efforts
•Sustainable
•Pack it out training programs
•Protect
•Reclaim
•Restore
•Cross jurisdiction planning
•I-90 corridor
•Trip planning
•Social networking
•Condition reports
•Graphic education tools
•Online reports
•Online education tools
•Public access
•Recreational infrastructure
•Long trajectory planning
•NGOs
•Uniform management across jurisdictions
•Exclusive use permits
•Law enforcement jurisdiction
•Volunteer maintenance
•Volunteer costs
•Volunteer surveys
•Nonprofits
$$$



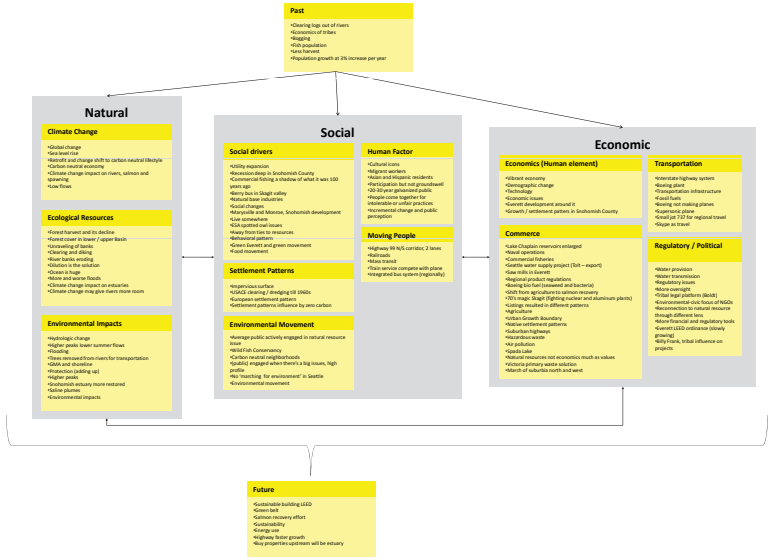
Group 3
Issues
• Growing
• Resource base
• Population
• Land availability
• Transportation (I-5, Hwy 2)
• Roads
• Pollution
• Density (w/UGB)
• School district services
• Services
• Healthy/dependence
• Education services
-
• Congestion
• Built legacy
• Commuter rail
• Decreased electricity and gas usage
• Water retention
Group 2
Future Employment Base
• TOD
• Out migration (north and west, ?east to Cle Ellum)
• Land use and development patterns
• Commuting in/out of county
• Cheaper/more expensive real estate
• Demographics
• Price of land and housing
• Education level
• Electric car ubiquitous
• Skill set
• Income level
• Urban/metropolitan
• Intellectual property
• More 'new' development
• Technology
• KC economic northward migration
• Housing stock
• Waste water
Group 1
Today's Economy
• Boeing (Aerospace)
• Manufacturing
• Labor negotiations
• Engineering
• Commercial airplane market
• Suppliers
• Employees
• Built environment
• Density

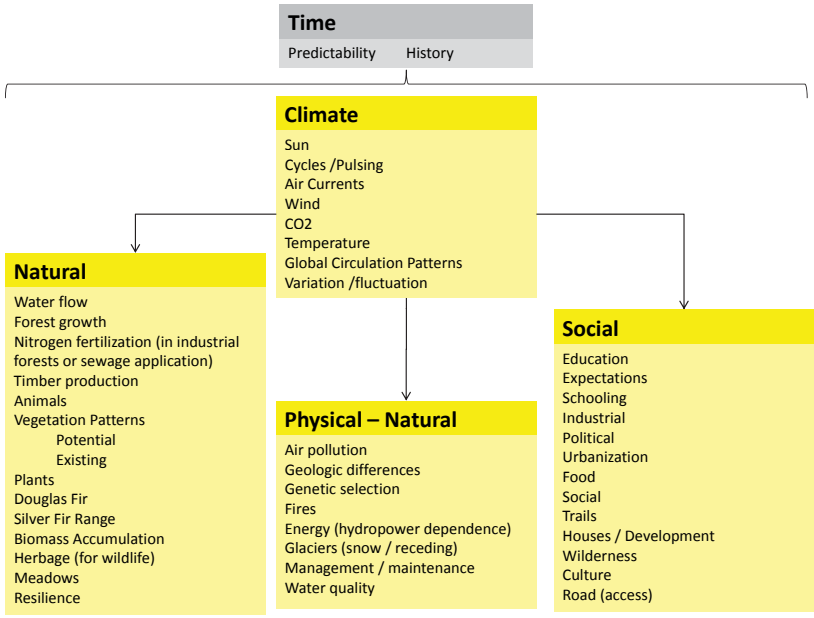


Major Drivers
Human Use and Extraction of Environment
• Alpine Lakes Wilderness
• Changing Values
• Fragmentation of boundary
• Population change
• Class I airsheds
• Expectations
• Recreation
• Public perception
• Agricultural land
• Water use
• Clash of sea level rise, salmon and ag.
• Regulatory changes
• Dikes
• Combined effects
Climate Changes
• Precipitation change
• Pacific Decadal Oscillation
• Climate variability
• Natural Variability
• Population growth
• Big changes in snow
•Increased seasoned cycles
•Potential increased extreme weather events
• Tree line changes
• Warming streams
• Sensitive areas (low elevation)
• Decreased snowpack
• Environmental changes
• Evapo-transpiration
• Acidification of ocean waters
• Impact distribution
• Regional warming
• Fires (incidence and probability)
• Wind storms
• Temperature increase
Is modulated through
Institutions Governing Human Action
Laws
• Land use laws
• Water rights laws
• Treaty rights (fish and wildlife)
• Regulatory changes
• ESA
• Decisions, decreased climate change
• Salmon management
• Clean Air Act
• Regional Hazes Rule
• Emissions
• Boldt Decision
• Growth Boundaries
• Rural vs. urban regulations
• Shoreline Management Act
• Clean Water Act
• Managed Water Supply
• Ecosystem Health Management
• Forest Management
• Fire Suppression Management
Actors
•Tulalip Tribes
•Regional planning commissions
•National parks
•Western regional air partnership
•NOAA
Human Activities
Urban Problems
• Geopolitical problems
• Visibility of Wilderness (proximity to urban area)
• Human health
• Fine scale particulates
• Large industrial pollution sources
• Seattle's impacts on wilderness
Emissions
• Natural visibility conditions
• Implementation of visibility rule
• Wild lands affect urban areas
• Cross boundary impacts
• Pest susceptibility
• Transition from understanding impacts (local, cumulative then remote effects)
• Wood burning stoves and fireplaces
• Sources (NOx, Diesel, particulates)
Wildland Urban Interface
• Demographic
• Bedroom communities
• Traffic
• Development
Environment and Natural Systems
Air Quality
Marine
• Sea level rise
• Puget Sound circulation
• Salt water intrusion
• Acidification impacts
• Upwelling changes
• Estuary
Waters
• Western Water Law
• Exempt wells
• Ground water uncertainty
• Resident fish
• Stream temperature exceedance
• Water rights
• Warming
• Water supply sensitivity (to climate change)
• Winter runoff
• Summer and Fall low stream flows
• Transition Basins (rain, snow)
• Rain storms
• Peak Streamflow changes
• Snowpack loss
• Soil moisture
• Food web
• Flooding
• Flooding frequency
• Salmon eggs and habitat
• Anadromous fish
• Freshwater inputs (timing)
Forests
• Environmental health
• Forest insects
• Insects life cycles
• Tree susceptibility (pests, air quality)
• Drought stress
• Ecological impacts
• Use values
• Laws



Social / Behavioral
Social drivers
•Utility expansion
•Recession deep in Snohomish County
•Commercial fishing a shadow of what it was 100 years ago
•Berry bus in Skagit valley
•Natural base industries
•Social changes
•Marysville and Monroe, Snohomish development
•Live somewhere
•ESA spotted owl issues
•Away from ties to resources
•Behavioral pattern
•Green Everett and green movement
•Food movement
Human Factor
•Cultural icons
•Migrant workers
•Asian and Hispanic residents
•Participation but not groundswell
•20-30 year galvanized public
•People come together for intolerable or unfair practices
•Incremental change and public perception
Economics (Human element)
•Vibrant economy
•Demographic change
•Technology
•Economic issues
•Everett development around it
•Growth / settlement patters in Snohomish County
Past
•Clearing logs out of rivers
•Economics of tribes
•Bogging
•Fish population
•Less harvest
•Population growth at 3% increase per year
Built Environment + Resources
Climate change
•Global change
•Sea level rise
•Retrofit and change shift to carbon neutral lifestyle
•Carbon neutral economy
•Climate change impact on rivers, salmon and spawning
•Low flows
Ecological Resources
•Forest harvest and its decline
•Forest cover in lower / upper Basin
•Unraveling of banks
•Clearing and diking
•River banks eroding
•Dilution is the solution
•Ocean is huge
•More and worse floods
•Climate change impact on estuaries
•Climate change may give rivers more room
Moving People
•Highway 99 N/S corridor, 2 lanes
•Railroads
•Mass transit
•Train service compete with plane
•Integrated bus system (regionally)
Transportation
•Interstate highway system
•Boeing plant
•Transportation infrastructure
•Fossil fuels
•Boeing not making planes
•Supersonic plane
•Small jot 737 for regional travel
•Skype as travel
Settlement Patterns
•Impervious surface
•USACE clearing / dredging till 1960s
•European settlement pattern
•Settlement patterns influence by zero carbon
Commerce
•Lake Chaplain reservoirs enlarged
•Naval operations
•Commercial fisheries
•Seattle water supply project (Tolt – export)
•Saw mills in Everett
•Regional product regulations
•Boeing bio fuel (seaweed and bacteria)
•Shift from agriculture to salmon recovery
•70's magic Skagit (fighting nuclear and aluminum plants)
•Listings resulted in different patterns
•Agriculture
•Urban Growth Boundary
•Native settlement patterns
•Suburban highways
•Hazardous waste
•Air pollution
•Spada Lake
•Natural resources not economics much as values
•Victoria primary waste solution
•March of suburbia north and west
Governance
Regulatory / Political
•Water provision
•Water transmission
•Regulatory issues
•More oversight
•Tribal legal platform (Boldt)
•Environmental-civic focus of NGOs
•Reconnection to natural resource through different lens
•More financial and regulatory tools
•Everett LEED ordinance (slowly growing)
•Billy Frank, tribal influence on projects
Environmental Movement
•Average public actively engaged in natural resource issue
•Wild Fish Conservancy
•Carbon neutral neighborhoods
•(public) engaged when there's a big issues, high profile
•No 'marching for environment' in Seattle
•Environmental movement
Environmental Impacts
•Hydrologic change
•Higher peaks lower summer flows
•Flooding
•Trees removed from rivers for transportation
•GMA and shoreline
•Protection (adding up)
•Higher peaks
•Snohomish estuary more restored
•Saline plumes
•Environmental impacts
Future
•Sustainable building LEED
•Green belt
•Salmon recovery effort
•Sustainability
•Energy use
•Highway faster growth
•Buy properties upstream will be estuary


Past
Natural
Climate Change
Ecological Resources
Environmental Impacts
Social
Social drivers
Settlement Patterns
Environmental Movement
Human Factor
Moving People
Economic
Economics (Human element)
Commerce
Transportation
Regulatory / Political
Future


Time
Predictability
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Climate
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Silver Fir Range
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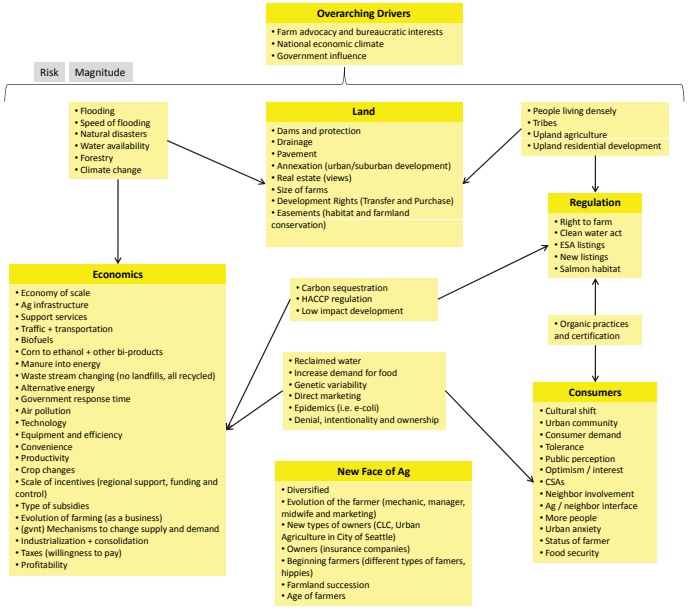
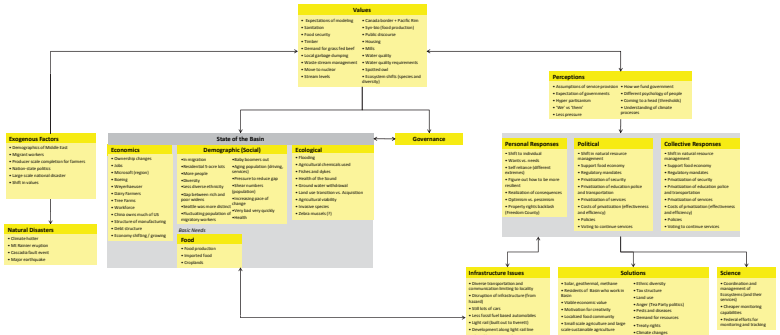
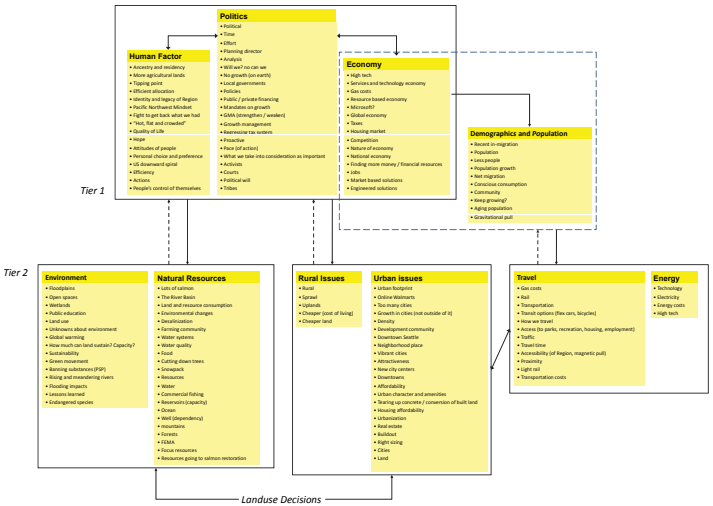
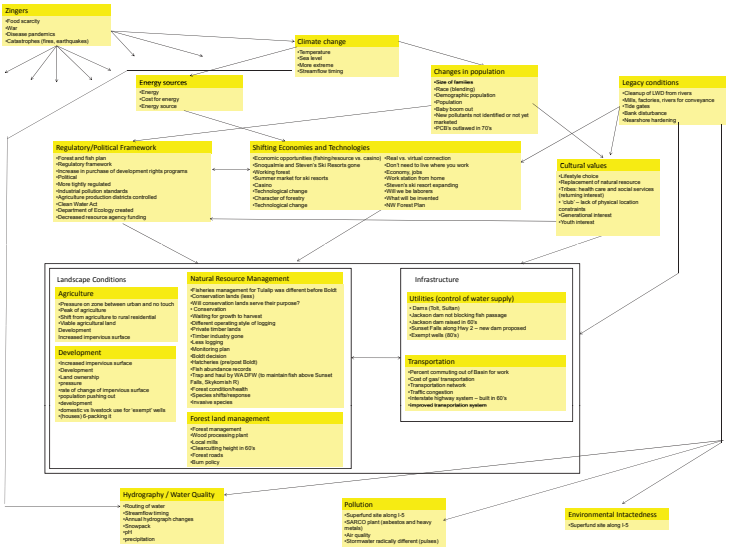
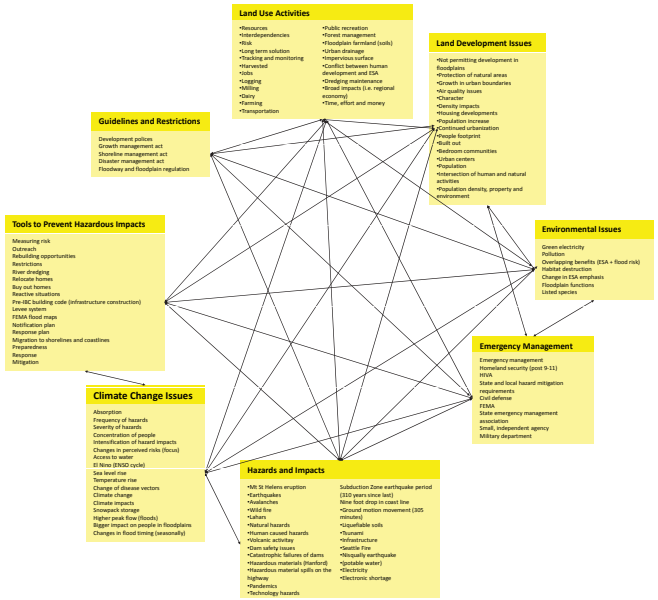
Social
Trails
Houses / Development
Wilderness
Culture
Road (access)

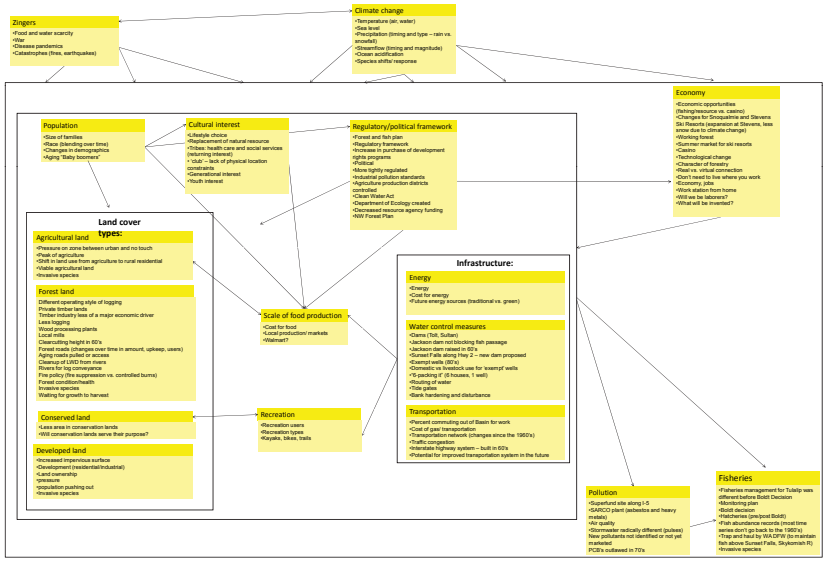

Overarching Drivers
• Farm advocacy and bureaucratic interests
• National economic climate
• Government influence
Risk
Magnitude
• Flooding
• Speed of flooding
• Natural disasters
• Water availability
• Forestry
• Climate change
Land
• Dams and protection
• Drainage
• Pavement
• Annexation (urban/suburban development)
• Real estate (views)
• Size of farms
• Development Rights (Transfer and Purchase)
• Easements (habitat and farmland conservation)
• People living densely
• Tribes
• Upland agriculture
• Upland residential development
Regulation
• Right to farm
• Clean water act
• ESA listings
• New listings
• Salmon habitat
Economics
• Economy of scale
• Ag infrastructure
• Support services
• Traffic + transportation
• Biofuels
• Corn to ethanol + other bi-products
• Manure into energy
• Waste stream changing (no landfills, all recycled)
• Alternative energy
• Government response time
• Air pollution
• Technology
• Equipment and efficiency
• Convenience
• Productivity
• Crop changes
• Scale of incentives (regional support, funding and control)
• Type of subsidies
• Evolution of farming (as a business)
• (gvnt) Mechanisms to change supply and demand
• Industrialization + consolidation
• Taxes (willingness to pay)
• Profitability
• Carbon sequestration
• HACCP regulation
• Low impact development
• Organic practices and certification
• Reclaimed water
• Increase demand for food
• Genetic variability
• Direct marketing
• Epidemics (i.e. e-coli)
• Denial, intentionality and ownership
Consumers
• Cultural shift
• Urban community
• Consumer demand
• Tolerance
• Public perception
• Optimism / interest
• CSAs
• Neighbor involvement
• Ag / neighbor interface
• More people
• Urban anxiety
• Status of farmer
• Food security
New Face of Ag
• Diversified
• Evolution of the farmer (mechanic, manager, midwife and marketing)
• New types of owners (CLC, Urban Agriculture in City of Seattle)
• Owners (insurance companies)
• Beginning farmers (different types of famers, hippies)
• Farmland succession
• Age of farmers

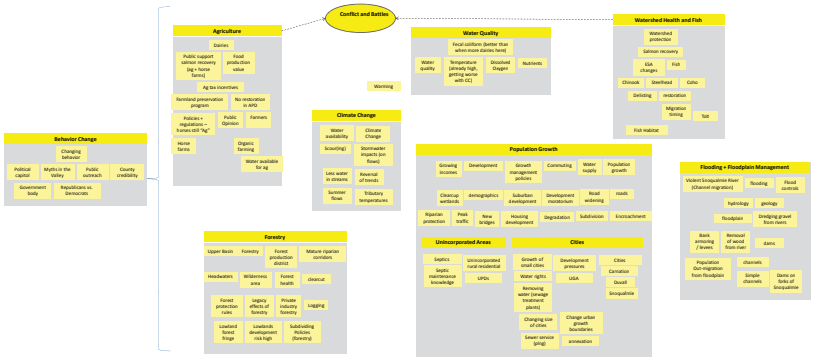

Values
Perceptions
Exogenous Factors
Natural Disasters
State of the Basin
Economics
Demographic (Social)
Ecological
Basic Needs
Food
Governance
Personal Responses
Political
Collective Responses
Infrastructure Issues
Solutions
Science

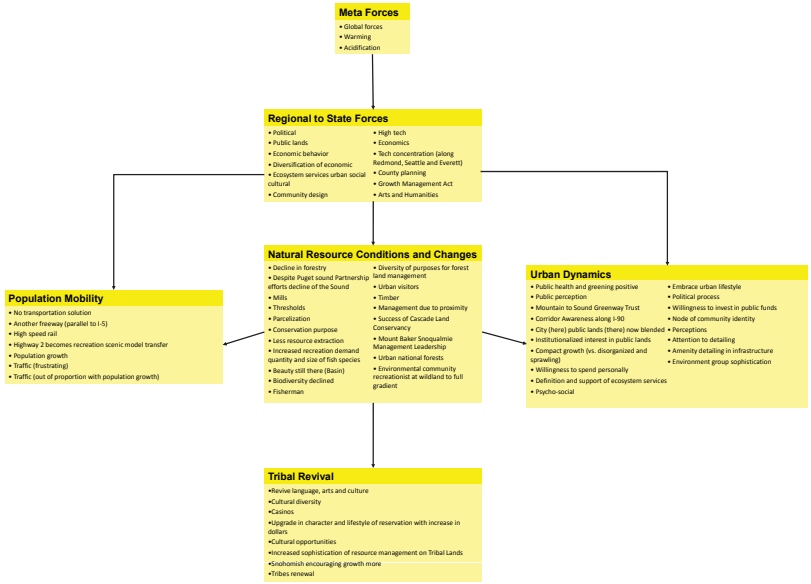

Politics
Human Factor
Economy
Demographics and Population
Tier 1
Tier 2
Environment
Natural Resources
Rural Issues
Urban issues
Travel
Energy
Landuse Decisions


Zingers
Climate change
Energy sources
Changes in population
Legacy conditions
Regulatory/Political Framework
Shifting Economies and Technologies
Cultural values
Landscape Conditions
Agriculture
Development
Natural Resource Management
Forest land management
Infrastructure
Utilities (control of water supply)
Transportation
Hydrography / Water Quality
Pollution
Environmental Intactedness


Land Use Activities
Land Development Issues
Guidelines and Restrictions
Tools to Prevent Hazardous Impacts
Environmental Issues
Emergency Management
Climate Change Issues
Hazards and Impacts


Zingers
Climate change
Population
Cultural interest
Regulatory/political framework
Economy
Land cover types:
Agricultural land
Forest land
Conserved land
Developed land
Infrastructure:
Energy
Water control measures
Transportation
Scale of food production
Recreation
Pollution
Fisheries





Characterization / data collection / analysis

Watershed framework	Maps	Fill
Technology	Coordination	Protection
Global warming	'remarkable restoration" /	Wash deposits
Skill set of biologist	successful	Harmful algae blooms
Delineation	Carbon sequestration	Sediment movement
(limited) land area	Long tail of data	Nearshore
Data	Impairment	Web(site)
Estuary	Storm intensity	Research (scientist)
University role	Accuracy	Restoration
Scientific community Ecological	Precision	Microsoft
approach	Sustainability	Basin (distance to urban core)
Digital data	Critical areas	
Sensors	Rural(ness)	
Number of species	Coastal streams	

Major Drivers or Stressors

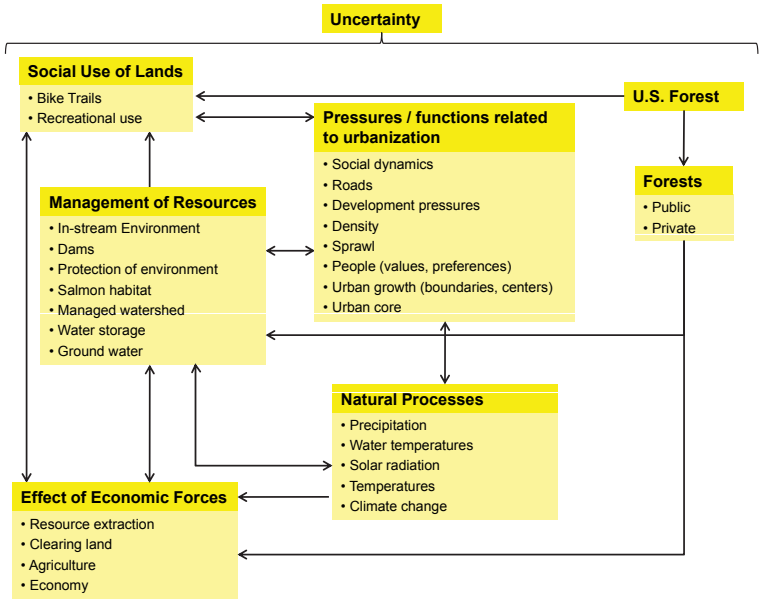
Population
Where development is going to go
Available land
Land value
Rapidly urbanizing
Conflict
Paradigm shift
Suburbanization / megalopolis
National parks land
People's behavior

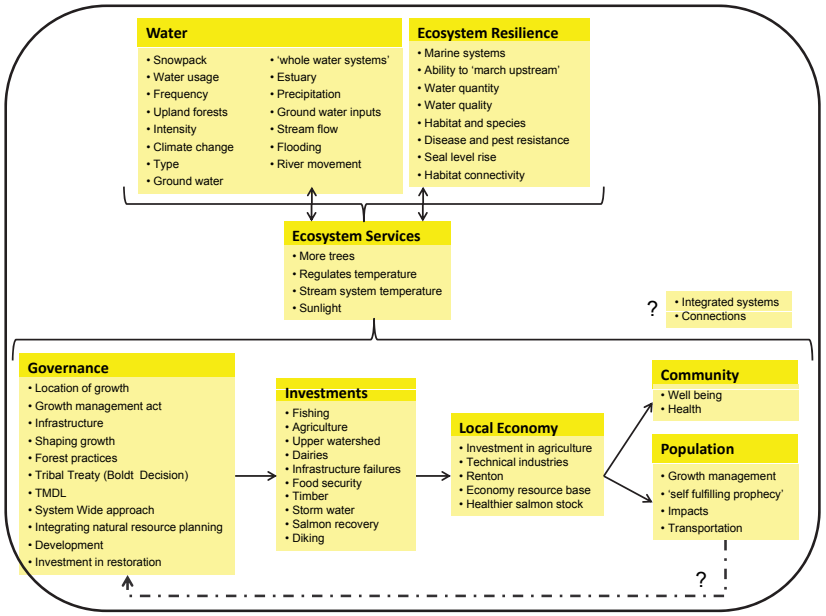
Synthesis / outreach / education

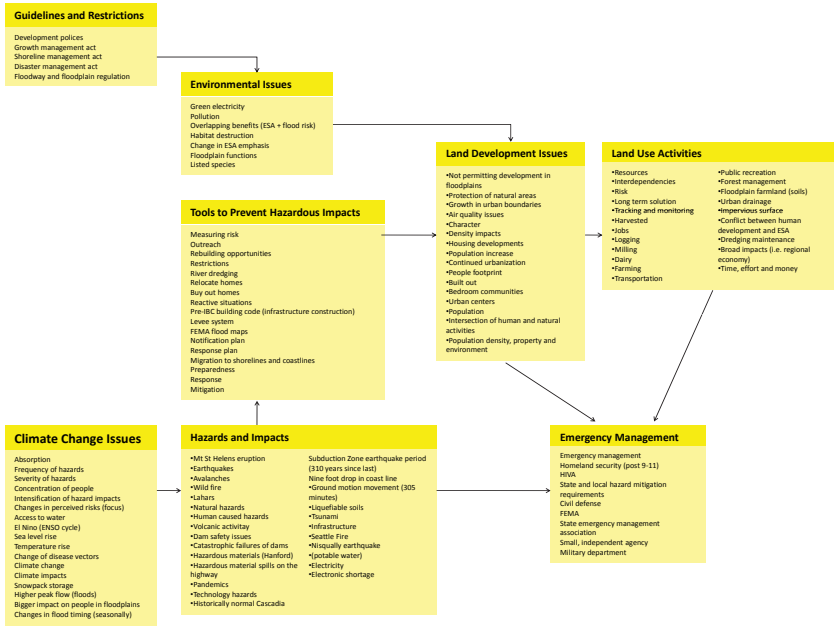
Democratize	County / city
Friendliness	government
Developers	Landowners
Jurisdictions	
Farmers	
Agencies	

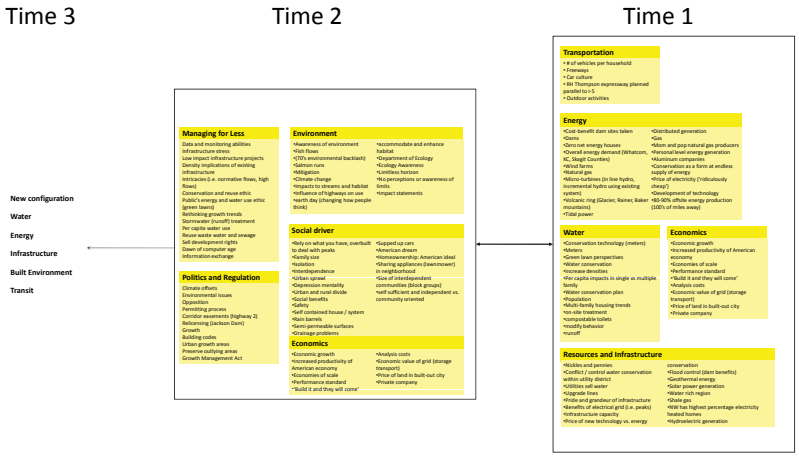
Opportunities / constraints

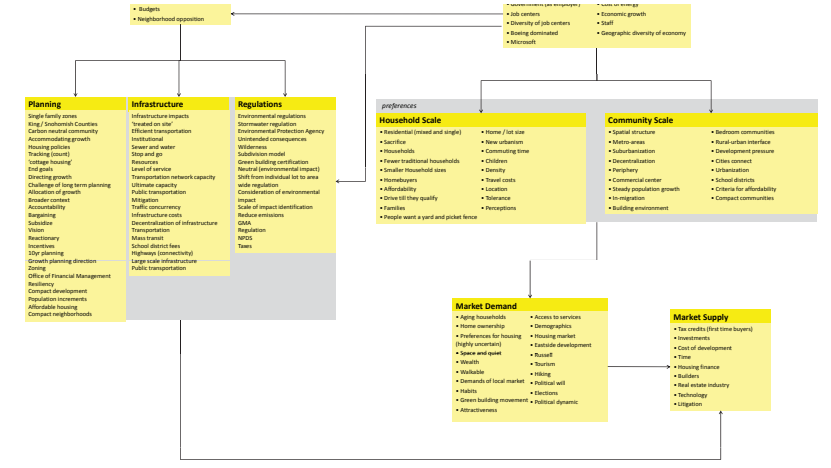
Traffic congestion	Marshland	Lake Stevens (plateau)
Unraveling streams	Restrictions	Slow food
Permits	Zoning	Political
Steep slopes	Enforcement hammer	Building conventions
Buffers	New development	Political pressure
Water quality	Local codes	Regulations
Recognition of significance	Violations	Institutional knowledge
Land availability	Agricultural	County ownership
Farmer – relations	Drain (ing)	Mitigation
Carbon footprint	Energy	
Floodplain	Sultan (terrace)	

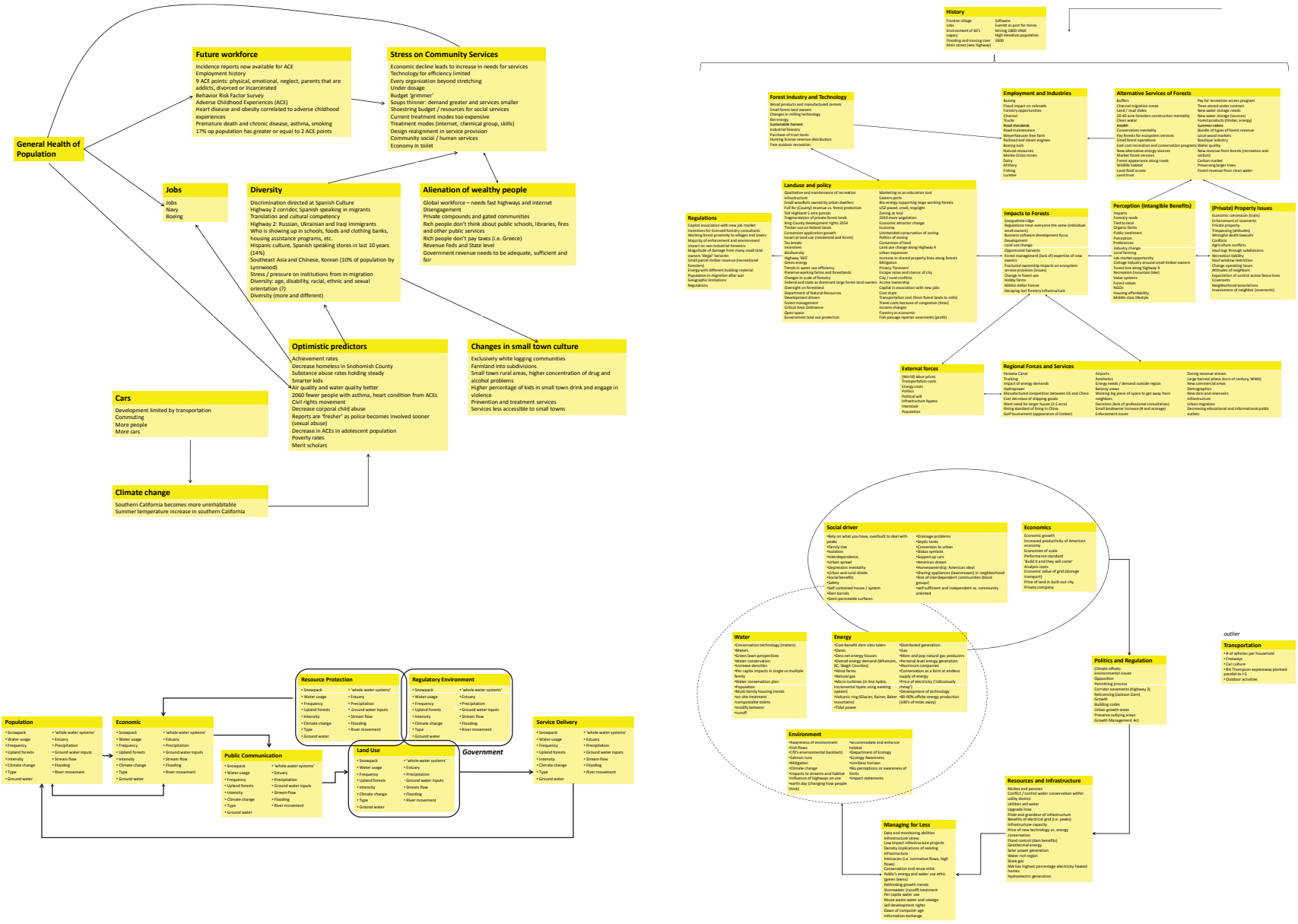



Water
• Snowpack
• Water usage
• Frequency
• Upland forests
• Intensity
• Climate change
• Type
• Ground water
• 'whole water systems'
• Estuary
• Precipitation
• Ground water inputs
• Stream flow
• Flooding
• River movement
Ecosystem Resilience
• Marine systems
• Ability to 'march upstream'
• Water quantity
• Water quality
• Habitat and species
• Disease and pest resistance
• Seal level rise
• Habitat connectivity
Ecosystem Services
• More trees
• Regulates temperature
• Stream system temperature
• Sunlight
?
• Integrated systems
• Connections
Governance
• Location of growth
• Growth management act
• Infrastructure
• Shaping growth
• Forest practices
• Tribal Treaty (Boldt Decision)
• TMDL
• System Wide approach
• Integrating natural resource planning
• Development
• Investment in restoration
Investments
• Fishing
• Agriculture
• Upper watershed
• Dairies
• Infrastructure failures
• Food security
• Timber
• Storm water
• Salmon recovery
• Diking
Local Economy
• Investment in agriculture
• Technical industries
• Renton
• Economy resource base
• Healthier salmon stock
Community
• Well being
• Health
Population
• Growth management
• 'self fulfilling prophecy'
• Impacts
• Transportation
?


Guidelines and Restrictions
Development polices
Growth management act
Shoreline management act
Disaster management act
Floodway and floodplain regulation
Environmental Issues
Green electricity
Pollution
Overlapping benefits (ESA + flood risk)
Habitat destruction
Change in ESA emphasis
Floodplain functions
Listed species
Land Development Issues
•Not permitting development in floodplains
•Protection of natural areas
•Growth in urban boundaries
•Air quality issues
•Character
•Density impacts
•Housing developments
•Population increase
•Continued urbanization
•People footprint
•Built out
•Bedroom communities
•Urban centers
•Population
•Intersection of human and natural activities
•Population density, property and environment
Land Use Activities
•Resources
•Interdependencies
•Risk
•Long term solution
•Tracking and monitoring
•Harvested
•Jobs
•Logging
•Milling
•Dairy
•Farming
•Transportation
•Public recreation
•Forest management
•Floodplain farmland (soils)
•Urban drainage
•Impervious surface
•Conflict between human development and ESA
•Dredging maintenance
•Broad impacts (i.e. regional economy)
•Time, effort and money
Tools to Prevent Hazardous Impacts
Measuring risk
Outreach
Rebuilding opportunities
Restrictions
River dredging
Relocate homes
Buy out homes
Reactive situations
Pre-IBC building code (infrastructure construction)
Levee system
FEMA flood maps
Notification plan
Response plan
Migration to shorelines and coastlines
Preparedness
Response
Mitigation
Climate Change Issues
Absorption
Frequency of hazards
Severity of hazards
Concentration of people
Intensification of hazard impacts
Changes in perceived risks (focus)
Access to water
El Nino (ENSO cycle)
Sea level rise
Temperature rise
Change of disease vectors
Climate change
Climate impacts
Snowpack storage
Higher peak flow (floods)
Bigger impact on people in floodplains
Changes in flood timing (seasonally)
Hazards and Impacts
•Mt St Helens eruption
•Earthquakes
•Avalanches
•Wild fire
•Lahars
•Natural hazards
•Human caused hazards
•Volcanic activitay
•Dam safety issues
•Catastrophic failures of dams
•Hazardous materials (Hanford)
•Hazardous material spills on the highway
•Pandemics
•Technology hazards
•Historically normal Cascadia
Subduction Zone earthquake period (310 years since last)
Nine foot drop in coast line
•Ground motion movement (305 minutes)
•Liquefiable soils
•Tsunami
•Infrastructure
•Seattle Fire
•Nisqually earthquake
•(potable water)
•Electricity
•Electronic shortage
Emergency Management
Emergency management
Homeland security (post 9-11)
HIVA
State and local hazard mitigation requirements
Civil defense
FEMA
State emergency management association
Small, independent agency
Military department


Time 3
Time 2
Time 1
New configuration
Water
Energy
Infrastructure
Built Environment
Transit
Managing for Less
Politics and Regulation
Environment
Social driver
Economics
Transportation
Energy
Water
Economics
Resources and Infrastructure


• Budgets
• Neighborhood opposition
• Job centers
• Diversity of job centers
• Boeing dominated
• Microsoft
• Economic growth
• Staff
• Geographic diversity of economy
Planning
Infrastructure
Regulations
preferences
Household Scale
Community Scale
Market Demand
Market Supply


General Health of Population
Future workforce
Incidence reports now available for ACE
Employment history
9 ACE points: physical, emotional, neglect, parents that are addicts, divorced or incarcerated
Behavior Risk Factor Survey
Adverse Childhood Experiences (ACE)
Heart disease and obesity correlated to adverse childhood experiences
Premature death and chronic disease, asthma, smoking
17% op population has greater or equal to 2 ACE points
Stress on Community Services
Economic decline leads to increase in needs for services
Technology for efficiency limited
Every organization beyond stretching
Under dosage
Budget 'grimmer'
Soups thinner: demand greater and services smaller
Shoestring budget / resources for social services
Current treatment modes too expensive
Treatment modes (internet, chemical group, skills)
Design realignment in service provision
Community social / human services
Economy in toilet
Jobs
Jobs
Navy
Boeing
Diversity
Discrimination directed at Spanish Culture
Highway 2 corridor, Spanish speaking in migrants
Translation and cultural competency
Highway 2: Russian, Ukrainian and Iraqi immigrants
Who is showing up in schools, foods and clothing banks, housing assistance programs, etc.
Hispanic culture, Spanish speaking stores in last 10 years (14%)
Southeast Asia and Chinese, Korean (10% of population by Lynnwood)
Stress / pressure on institutions from in-migration
Diversity: age, disability, racial, ethnic and sexual orientation (?)
Diversity (more and different)
Alienation of wealthy people
Global workforce – needs fast highways and internet
Disengagement
Private compounds and gated communities
Rich people don't think about public schools, libraries, fires and other public services
Rich people don't pay taxes (i.e. Greece)
Revenue Feds and State level
Government revenue needs to be adequate, sufficient and fair
Optimistic predictors
Achievement rates
Decrease homeless in Snohomish County
Substance abuse rates holding steady
Smarter kids
Air quality and water quality better
2060 fewer people with asthma, heart condition from ACEs
Civil rights movement
Decrease corporal child abuse
Reports are 'fresher' as police becomes involved sooner (sexual abuse)
Decrease in ACEs in adolescent population
Poverty rates
Merit scholars
Changes in small town culture
Exclusively white logging communities
Farmland into subdivisions
Small town rural areas, higher concentration of drug and alcohol problems
Higher percentage of kids in small town drink and engage in violence
Prevention and treatment services
Services less accessible to small towns
Cars
Development limited by transportation
Commuting
More people
More cars
Climate change
Southern California becomes more uninhabitable
Summer temperature increase in southern California
History
Frontier village
Jobs
Environment of 60's
Legacy
Flooding and moving river
Main street (was highway)
Software
Everett as port for mines
Mining 1800-1940
High elevation population
1800
Forest Industry and Technology
Wood products and manufactured centers
Small forest land owners
Changes in milling technology
Bio-energy
Sustainable harvest
Industrial forestry
Purchase of trust lands
Hunting license revenue distribution
Free outdoor recreation
Employment and Industries
Boeing
Flood impact on railroads
Forestry opportunities
Clearcut
Trucks
Road standards
Road maintenance
Weyerhaeuser tree farm
Railroad and steam engines
Boeing rush
Natural resources
Monte Cristo mines
Dairy
Military
Fishing
Lumber
Alternative Services of Forests
Buffers
Channel migration zones
Land / mud slides
20-40 acre foresters construction mentality
Clean water
Health
Conservation mentality
Pay forests for ecosystem services
Small forest operations
East cost recreation and conservation programs
New alternative energy sources
Market forest services
Forest appearance along roads
Wildlife habitat
Local food access
Land trust
Pay for recreation access program
Trees stored under contract
New water storage needs
New water storage (sources)
Forest products (timber, energy)
Summer cabins
Bundle of types of forest revenue
Local wood markets
Boutique industry
Water quality
New revenue from forests (recreation and carbon)
Carbon market
Preserving larger trees
Forest revenue from clean water
Landuse and policy
Qualitative and maintenance of recreation infrastructure
Small woodlots owned by urban dwellers
Pull for (County) revenue vs. forest protection
Tod highland 5 acre parcels
Tax incentives for private forest lands
King County development rights 2054
Timber use on federal lands
Conversion application growth
Issues at land use (residential and forest)
Tax breaks
Incentives
Biodiversity
Highway 'GEO'
Green energy
Trends in water use efficiency
Preserve working farms and forestlands
Changes in scale of forestry
Federal and state as dominant large forest land owners
Oversight on forestland
Development of Natural Resources
Development drivers
Forest management
Critical Area Ordinance
Open space
Government land use protection
Marketing as an education tool
Eastern ports
Bio-energy supporting large working forests
LOG paved, small, stoplight
Zoning as tool
Tax base stabilization
Economic entrance change
Economy
Unintended conservation of zoning
Politics of zoning
Conversion of land
Land use change along Highway 9
Urban expansion
Increase in shared property lines along forests
Mitigation
Privacy 'foresters'
Escape noise and clamor of city
City / rural conflicts
Access ownership
Capital in association with new jobs
Tourism
Transportation cost (from forest lands to mills)
Travel costs because of congestion (time)
Income changes
Forestry as economic
Fish passage riparian easements (profit)
Regulations
Capitol association with new job market
Incentives for licensed forestry consultants
Working forest proximity to villages and towns
Majority of enforcement and environment impact on non-industrial foresters
Magnitude of damage from many small land owners 'illegal' harvests
Non-industrial timber revenue (recreational foresters)
Energy with different building material
Population in migration after war
Geographic limitations
Regulations
Impacts to Forests
Snoqualmie ridge
Regulations treat everyone the same (individual small owners)
Business software development focus
Development
Land use change
Opportunist harvests
Forest management (lack of) expertise of new owners
Fractured ownership impacts on ecosystem service provision (issues)
Change in forest use
Hobby farms
Million-dollar homes
Decaying lost forestry infrastructure
Perception (Intangible Benefits)
Viewers
Forestry roads
Tied to land
Organic farms
Public sentiment
Perception
Preferences
Industry change
Local farming
Job market opportunity
Cottage industry around small timber owners
Forest loss along highway 9
Recreation (mountain bike)
Value systems
Forest values
NGOs
Housing affordability
Middle-class lifestyle
(Private) Property Issues
Economic concession (trails)
Enforcement of covenants
Private property
Trespassing (attitudes)
Wrongful death lawsuits
Conflicts
Agriculture conflicts
Haul logs through subdivisions
Recreation liability
Property value reduction
Change operating hours
Attitudes of neighbors
Expectation of control across fence-lines
Covenants
Neighborhood associations
Invasiveness of neighbor (covenants)
External forces
(World) labor prices
Transportation costs
Energy costs
Politics
Political will
Infrastructure bypass
Interstate
Population
Regional Forces and Services
Panama Canal
Trucking
Impact of energy demands
Aesthetics
Manufactured competition between US and China
Cost decrease of shipping goods
Want need for larger house (2-5 acre)
Rising standard of living in China
Golf tournament (appearance of timber)
Airports
Aesthetics
Energy needs / demand outside region
Water quality
Warning like piece of space to get away from neighbors
Decisions (lack of professional consultation)
Small landowner increase (# and acreage)
Enforcement issues
Zoning revenue stream
Large harvest phase (turn of century, WWII)
New commercial areas
Recreation use
New dam and reservoirs
Infrastructure
Urban migration
Decreasing educational and informational public outlets
Social driver
•Rely on what you have, overbuilt to deal with peaks
•Family size
•Isolation
•Interdependence
•Urban sprawl
•Depression mentality
•Urban and rural divide
•Social benefits
•Safety
•Self contained house / system
•Rain barrels
•Semi-permeable surfaces
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•Conversion to urban
•Status symbols
•Sipped up cars
•American dream
•Homeownership: American ideal
•Sharing appliances (lawnmower) in neighborhood
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Economics
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Water
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•Multi-family housing trends
•on-site treatment
•compostable toilets
•modify behavior
•runoff
Energy
•Cost-benefit dam sites taken
•Dams
•Zero net energy houses
•Overall energy demand (Whatcom, KC, Skagit Counties)
•Wind farms
•Natural gas
•Micro-turbines (in line hydro, Whatcom Falls?) hydro using existing systems
•Volcanic ring (Glacier, Rainier, Baker mountains)
•Tidal power
•Distributed generation
•Gas
•More and pop natural gas producers
•Personal level energy generation
•Aluminum companies
•Conservation as a form at endless supply of energy
•Price of electricity (ridiculously cheap)
•Development of technology
•80-90% offsite energy production (100's of miles away)
Environment
•Awareness of environment
•Fish flows
•(70's environmental backlash)
•Salmon runs
•Mitigation
•Climate change
•Impacts to streams and habitat
•Influence of highways on use
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•Department of Ecology
•Ecology Awareness
•Limitless horizon
•No perceptions or awareness of limits
•Impact statements
outlier
Transportation
• # of vehicles per household
• Freeways
• Car culture
• I-84 Thompson expressway planned parallel to I-5
• Outdoor activities
Politics and Regulation
Climate offsets
Environmental issues
Opposition
Permitting process
Corridor easements (highway 2)
Relicensing (Jackson Dam)
Growth
Building codes
Urban growth areas
Preserve outlying areas
Growth Management Act
Resources and Infrastructure
Nickles and pennies
Conflict / control water conservation within utility district
Utilities sell water
Upgrade lines
Age and dependeur of infrastructure
Benefits of electrical grid (i.e. peaks)
Infrastructure capacity
Price of new technology vs. energy conservation
Flood control (dam benefits)
Geothermal energy
Solar power generation
Water rich region
Shale gas
NW has highest percentage electricity heated homes
Hydroelectric generation
Managing for Less
Data and monitoring abilities
Infrastructure stress
Low impact infrastructure projects
Density implications of existing infrastructure
Intricacies (i.e. normative flows, high flows)
Conservation and reuse ethic
Public's energy and water use ethic (green lawns)
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Stormwater (runoff) treatment
Per capita water use
Reuse waste water and sewage
Sell development rights
Dawn of computer age
Information exchange
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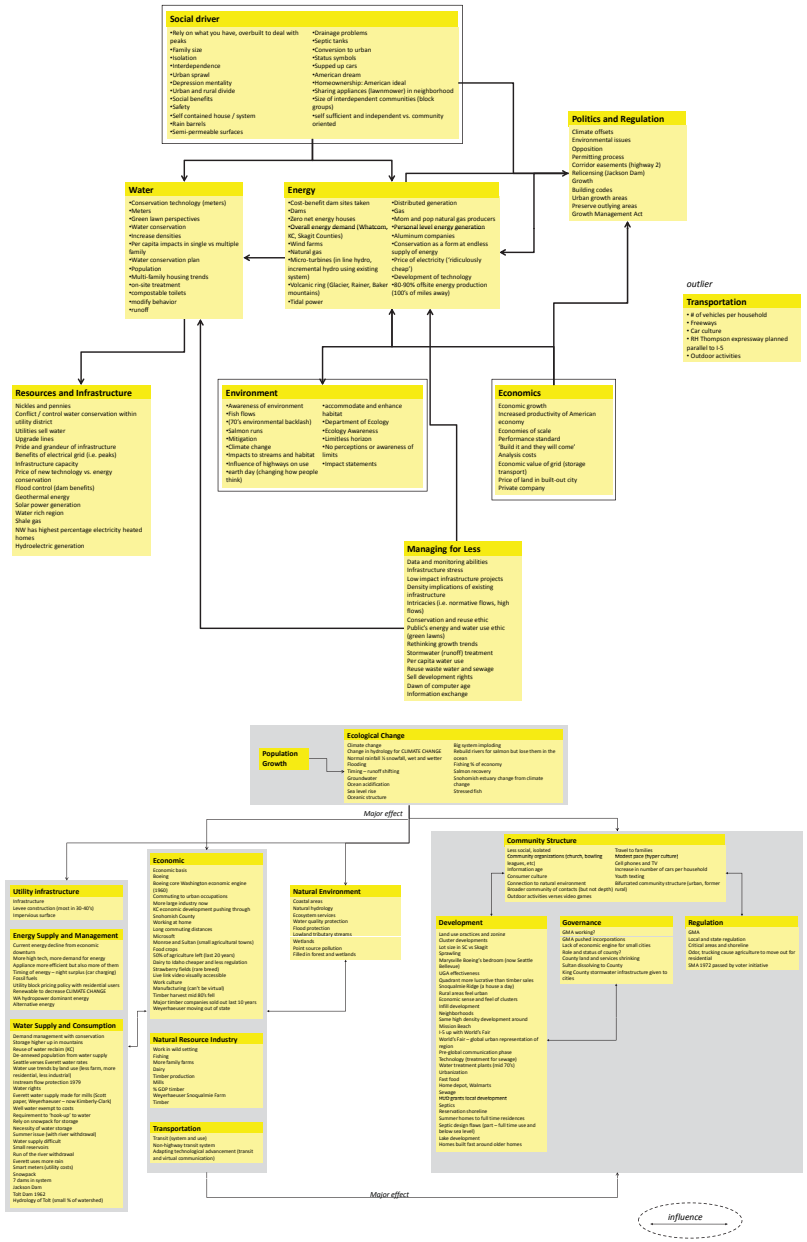
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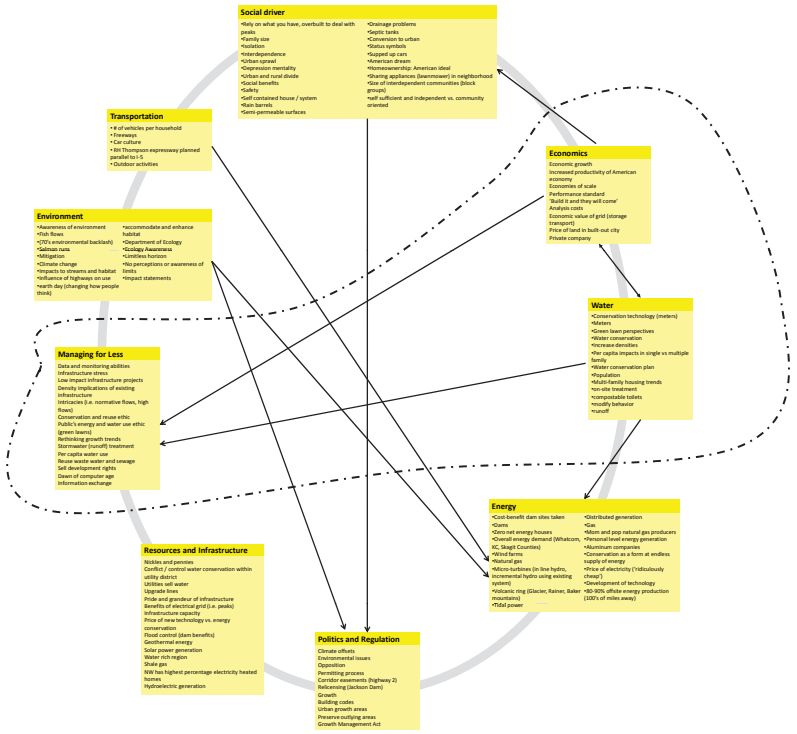
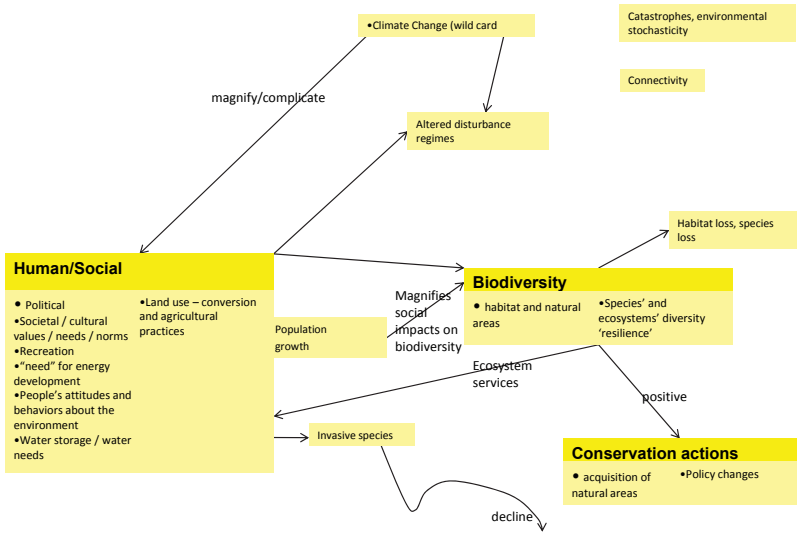
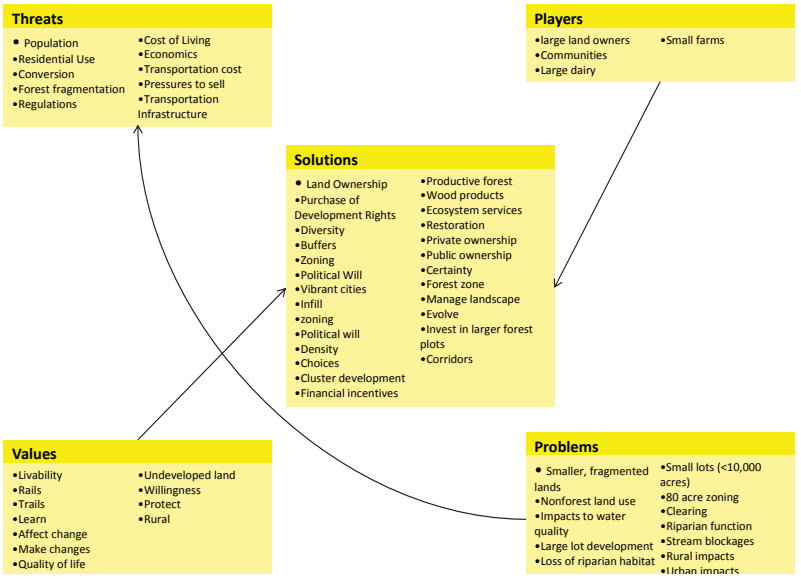
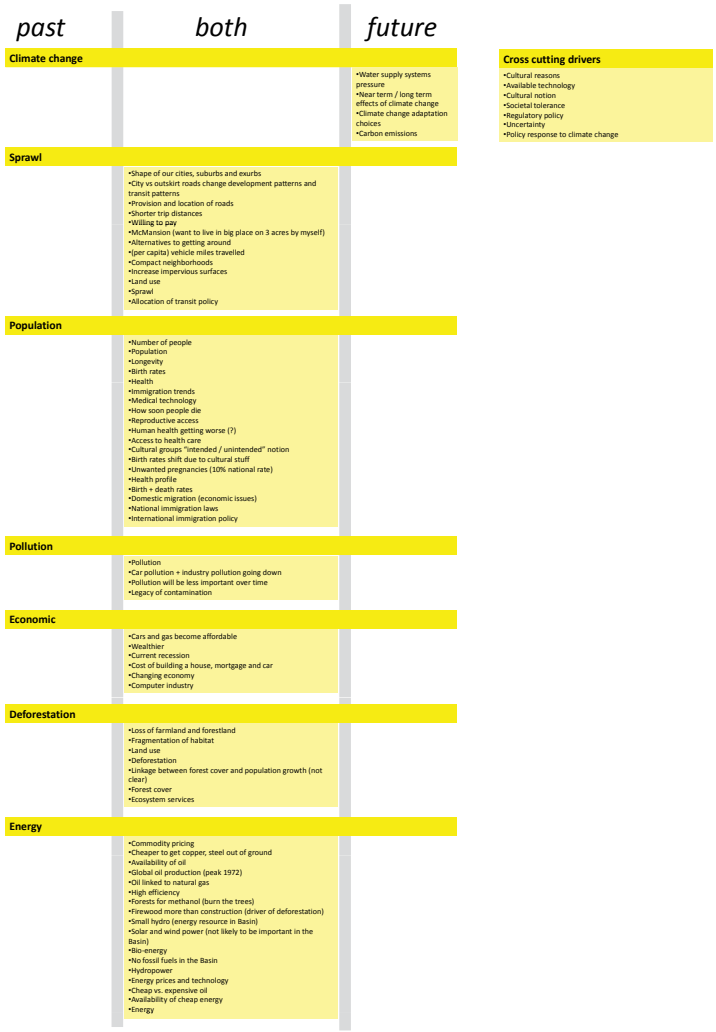
Ecological Change
Climate change
Change in hydrology for CLIMATE CHANGE
Normal rainfall % snowfall, wet and wetter
Flooding
Timing – runoff shifting
Ocean warming
Ocean acidification
Sea level rise
Oceanic structure
Big system imploding
Rebuild rivers for salmon but lose them in the ocean
Fishing % of economy
Salmon recovery
Snohomish estuary change from climate change
Stressed fish
Major effect
Utility Infrastructure
Infrastructure
Levee construction (most in 30-40's)
Impervious surface
Energy Supply and Management
Current energy decline from economic downturn
More high tech, more demand for energy
Appliance more efficient but also more of them
Timing of energy – night surplus (car charging)
Low link video virtually accessible
Utility block pricing policy with residential users
Renewable to decrease CLIMATE CHANGE
WA hydropower dominant energy
Alternative energy
Water Supply and Consumption
Demand management with conservation
Storage higher up in mountains
Reuse of water reclaim (KC)
De-annexed population from water supply
Seattle verses Everett water rates
Water use trends by land use (less farm, more residential, less industrial)
Instream flow protection 1979
Water rights
Everett water supply made for mills (Scott paper, Weyerhaeuser – now Kimberly-Clark)
Well water exempt to costs
Requirement to 'hook-up' to water
Rely on snowpack for storage
Rely on reservoir storage
Summer issue (left river withdrawal)
Water supply difficult
Small reservoirs
Run of the river withdrawal
Everett uses more rain
Smart meters (utility costs)
Snowpack
7 dams in system
Jackson Dam
Tolt Dam 1962
Hydrology of Tolt (small % of watershed)
Economic
Economic basis
Boeing
Boeing core Washington economic engine
Farming
Commuting to urban occupations
More large industry now
KC economic development pushing through Snohomish County
Working at home
Long commuting distances
Microsoft
Monroe and Sultan (small agricultural towns)
Food crops
50% of agriculture left (last 20 years)
Dairy to Idaho cheaper and less regulation
Strawberry fields (rare breed)
Low link video virtually accessible
Work culture
Manufacturing (can't be virtual)
Timber harvest mid 80's fell
Major timber companies sold out last 10 years
Weyerhaeuser moving out of state
Natural Resource Industry
Work in wild setting
Fishing
More family farms
Dairy
Timber production
Mills
% GDP timber
Weyerhaeuser Snoqualmie Farm
Timber
Transportation
Transit (system and use)
Non-highway transit system
Adapting technological advancement (transit and virtual communication)
Natural Environment
Coastal areas
Natural hydrology
Ecosystem services
Water quality protection
Flood protection
Lowland tributary streams
Wetlands
Point source pollution
Filled in forest and wetlands
Community Structure
Less social, isolated
Community organizations (church, bowling leagues, etc)
Information age
Consumer culture
Connection to natural environment
Broader community of contacts (but not depth)
Outdoor activities verses video games
Travel to families
Modest pace (hyper culture)
Cell phones and TV
Increase in number of cars per household
Youth texting
Bifurcated community structure (urban, former rural)
Development
Land use practices and zonine
Cluster developments
Lot size in SC vs Skagit
Sprawling
Shift from Boeing's bedroom (now Seattle Bellevue)
UGA effectiveness
Quadrant more lucrative than timber sales
Snoqualmie Ridge (a house a day)
Rural areas feel urban
Economic sense and feel of clusters
Infill development
Neighborhoods
Same high density development around Mission Beach
I-5 up with World's Fair
World's Fair – global urban representation of region
Pre-global communication phase
Technology (treatment for sewage)
Water treatment plants (mid 70's)
Urbanization
Fast food
Wal-Mart, Target, Walmarts
Sewage
MUD grants local development
Septics
Reservation shoreline
Summer homes to full-time residences
Septic design flaws (part – full time use and below sea level)
Lake development
Homes built fast around older homes
Governance
GMA working?
GMA pushed incorporations
Lack of economic engine for small cities
Role and status of county?
County land and services shrinking
Sultan dissolving to County
King County stormwater infrastructure given to cities
Regulation
GMA
Local and state regulation
Critical areas and shoreline
Odor, trucking cause agriculture to move out for residential
SMA 1972 passed by voter initiative
Major effect
influence


Social driver
•Rely on what you have, overbuilt to deal with peaks
•Family size
•Isolation
•Interdependence
•Urban sprawl
•Depression mentality
•Urban and rural divide
•Social benefits
•Safety
•Self contained house / system
•Rain barrels
•Semi-permeable surfaces
•Drainage problems
•Septic tanks
•Conversion to urban
•Status symbols
•Supped up cars
•American dream
•Homeownership: American ideal
•Sharing appliances (lawnmower) in neighborhood
•Size of interdependent communities (block groups)
•self sufficient and independent vs. community oriented
Transportation
• # of vehicles per household
• Freeways
• Car culture
• RH Thompson expressway planned parallel to I-5
• Outdoor activities
Economics
Economic growth
Increased productivity of American economy
Economies of scale
Performance standard
'Build it and they will come'
Analysis costs
Economic value of grid (storage transport)
Price of land in built-out city
Private company
Environment
•Awareness of environment
•Fish flows
•('70's environmental backlash)
•Salmon runs
•Mitigation
•Climate change
•Impacts to streams and habitat
•Influence of highways on use
•earth day (changing how people think)
•accommodate and enhance habitat
•Department of Ecology
•Ecology Awareness
•Limitless horizon
•No perceptions or awareness of limits
•Impact statements
Water
•Conservation technology (meters)
•Meters
•Green lawn perspectives
•Water conservation
•Increase densities
•Per capita impacts in single vs multiple family
•Water conservation plan
•Population
•Multi-family housing trends
•on-site treatment
•compostable toilets
•modify behavior
•runoff
Managing for Less
Data and monitoring abilities
Infrastructure stress
Low impact infrastructure projects
Density implications of existing infrastructure
Intricacies (i.e. normative flows, high flows)
Conservation and reuse ethic
Public's energy and water use ethic (green lawns)
Rethinking growth trends
Stormwater (runoff) treatment
Per capita water use
Reuse waste water and sewage
Sell development rights
Dawn of computer age
Information exchange
Energy
•Cost-benefit dam sites taken
•Dams
•Zero net energy houses
•Overall energy demand (Whatcom, IC, Skagit Counties)
•Wind farms
•Natural gas
•Micro-turbines (in line hydro, incremental hydro using existing system)
•Volcanic ring (Glacier, Rainer, Baker mountains)
•Tidal power
•Distributed generation
•Gas
•Mom and pop natural gas producers
•Personal level energy generation
•Aluminum companies
•Conservation as a form at endless supply of energy
•Price of electricity ('ridiculously cheap')
•Development of technology
•80-90% offsite energy production (100's of miles away)
Resources and Infrastructure
Nickles and pennies
Conflict / control water conservation within utility district
Utilities sell water
Upgrade lines
Pride and grandeur of infrastructure
Benefits of electrical grid (i.e. peaks)
Infrastructure capacity
Price of new technology vs. energy conservation
Flood control (dam benefits)
Geothermal energy
Solar power generation
Water rich region
Shale gas
NW has highest percentage electricity heated homes
Hydroelectric generation
Politics and Regulation
Climate offsets
Environmental issues
Opposition
Permitting process
Corridor easements (highway 2)
Relicensing (Jackson Dam)
Growth
Building codes
Urban growth areas
Preserve outlying areas
Growth Management Act







Cross cutting drivers

- Cultural reasons
- Available technology
- Cultural notion
- Societal tolerance
- Regulatory policy
- Uncertainty
- Policy response to climate change

Setting Environment

- Fish
- habitat
- Floodplain
- Air quality
- Wildlife

Not Opportunities and threats

- Prosperity
- Availability of land
- Oil
- Confinement
- Pressure for production
- Political change
- Competitive
- Market (global, value)

Forces (drivers)

- Import / export
- Tribes
- Sprawl
- Market
- Government
- Profitability
- In-migration
- USDA
- Environmental regulations
- Economy
- The Farm Bill
- Population density
- Burden(some)
- Trade regulations (WTO)
- Risk
- GMA
- Sprawl
- Prosperity
- Flooding

Solutions

- Net gain productivity
- Partnerships

Actors

- Smaller farms
- Small producer
- Farmers critical and necessary
- Local grocer
- WSDA
- Department of Ecology
- Commodity farms
- Tribes
- Supermarket
- Government
- More farmers

Values / Priorities

- Define fairness
- Responsibility
- Public health
- Good livable places
- Importance
- Prosperity
- Food security
- Democracy
- Importance
- How we value agriculture
- Security
- Sustainability
- Beauty

Left on Board

- Machinery
- Leasing minimum size
- More intensive farming
- Chosen a course
- Collectivity
- Vegetables
- Subsidize
- Industrialized
- Farm value
- Ag zones
- Vested interests
- Different type of agriculture
- Cheaper
- River
- Land values
- ESA
- Food
- Lettuce
- Pesticides
- Waste
- Harnessing
- Fresh
- Allocate rights
- Upland
- Open space status
- Environmental consequences
- Restoration
- Energy
- Benefits
- Grapes
- Sustainable lands strategy
- Cities
- Consequences
- Food miles
- Property rights / takings
- Local
- Rural interests
- Spread out population
- Incentives
- The public
- Stability
- Uncertainty about the future
- Everyone
- '5 acre parcels'
- 'back of farmer'
- Farming multiple small parcels
- Globally
- Obesity
- new vision of agriculture
- Performance
- Income / revenue
- East / West divide
- Big company
- land development phasing
- Permit
- Hay
- Exemption
- Large acreage production
- Good ag practices
- danger
- Pollution
- Soils
- Planning (how Agriculture is addressed)
- Soil capacity
- Slaughterhouse
- prepare
- Allocate burdens
- Infrastructure
- Kids
- Hillside
- Politics
- investments
- Stewardship fund
- Transportation (costs)
- Visual
- Perceptions
- (Leveling out the) playing field
- efficiency
- Conservation district
- Intolerable
- Tremendous variety of products
- Intensive uses
- Low income
- economic vitality
- Justice
- Social impact
- Priority
- Don't have enough farmers
- clean water
- Social responsibility
- Farmers markets
- Margin
- Ag board
- Year round
- transfer of productivity
- Baseline
- Property condemnation
- Agricultural definition
- RCW State law
- Polls showing
- economic sustainability
- Buffers
- Fragmentation
- County level
- No returns
- Neighborhood
- powerful
- Forestlands
- Not a Western Washington problem
- Diversifying markets and products
- Greenhouses
- Food desert
- Monroe
- Around the table
- Family
- Production facilities
- Higher value of land
- Tighter food regulations
- TMDL
- USFW
- Council
- Resistance
- Mowed lawns
- Value added products
- Mitigation
- Mindset
- Flexibility
- Bottomlands
- Potential
- Tracking contaminants
- Wetlands
- Clean Water Act
- Political arena
- 'make a living'
- Pressure
- Cost share
- Holding operations
- Tax program

East West Division

East west divide
Rural small town oriented
County resource allocation
Small communities (i.e. Snohomish, Darlington)
Casino
Trespassing on reservation

Quality of Life

Quality of life
opportunities (jobs and entertainment)
Health care (Everett national level)
Attractiveness of 1st class city
Urbanized
Freeways
Post WWII cul de sac subdivision
Symbiotic relationship between Bellevue and Seattle (2nd tier city)
Is Everett a 1st tier city?
No
Everett small town

Labor

Development of Brier
Flooded 10 times
Assuming driving to Seattle for higher education
Blue Collar / White collar transition
Nisui population
Battle of Everett
Wobbler (early labor movement)

Environment

High rise building
Draw to Snohomish for salary level
GMA artificial constraints
Drive till you qualify
Marysville population
Design standards
Salmon not in creek
How we treat our environment

History of Basin

Rucker Hill
Seagulls vs Bruins (rivalry)
Scott Paper
Cascade High School in Everett
Everett Rotary Club
Fractured county
Everett 1 mile dock into Port Garner Bay
Dairy
Buffalo farm in South Everett
Shingle mills
Natural resource industry
Everett as mill town
Weyerhaeuser

Transportation

Full day trip to get to Basin from Seattle
I-99 (not I-5)
Can't build subdivisions without impact on transportation
South of 120th Street in Everett, oriented to Seattle
Land use and transportation policy
After 3 no meetings in north Everett
Traffic
2023 Lynn light rail
Shift to older generation (?)

Labor and Education

Labor stability
Trust with largest labor union
Contract negotiations based on numbers (not emotions)
Generation worked on the waterfront
Kimberly Clark (last vestiges)
Export more for higher education than import
Imbalance of jobs and housing (60% of commuters to King County)
Strategic workforce planning
Retirement
Young folks leaving
70% of people who leave for 4 year college stay out
Low cost high quality care
Stormwater
Pollution

Social

Mount Lake Terrace Mink Farm
Abandoned BNS railroad to Redmond as a commuter corridor
Urban railroad between Everett and Seattle
Japanese Gulch (SW Everett Forested Land
Immigration of Spanish speaking population
Training
Homeless veterans by Sultan
Professionals vs unemployed
Change of workforce
High School Diploma to 2year certification requirements
Penitentiary / the Jail
Government decisions for location of things
Social services in Everett

Past, Present and Future of Everett and Snohomish County

JC Penny moves to Everett Mall
Landfill line fire to mixed use development
Everett Station multi-modal hub
Light industry been redeveloped (in downtown Everett)
Exodus of downtown Everett
Density not there
Young professional live in King County
Lack of identity with younger generation connection to Everett
Arts and culture

Business Competitiveness

Policy leaders at WA picking a side
Unemployment benefits (cost structure)
Workers comp
Reformers for industry
LNI
Pensions paid out (180 vs. single digit days)
Environmental regulations
Predictable and streamlined (Environmental regulations)
Government view of industry as 'bad guy'
Meeting standards (King vs Snohomish Counties)
Taxes
Snohomish County current administration
Goal of government to treat everyone equally
King County administration
Permits
Credits extended
Corporate income tax
Entrepreneurial region, starting business out but also at failing
Business (small startup) sticking it out long term
Education
Largest County without 4 year University
Job producer
Skilled workforce
Smart people key to innovation
Manufacturing
Aerospace
Boeing (technology company)
Naval economic importance
Private sector jobs
Cost of doing business
Mid sized cities: Arlington, Marysville, Everett
Planned actions (upfront and done by area, SEPA, Etc)
Being in Snohomish County since 1966
Everett, largest facility employment for Boeing in the world ($6B billion)
Boeing facility bigger economic engine than some country's entire GDP
South half of Everett oriented south towards Seattle
Predictability of regulation
Initial investment vs efficiency
Mitigation and costs upfront and not an individual project level
Competing with Microsoft for innovation
Energy provision (SC PUD, Seattle City Light, PSE)
Wheeling" buy energy on an open market
Snohomish PUD from BPA

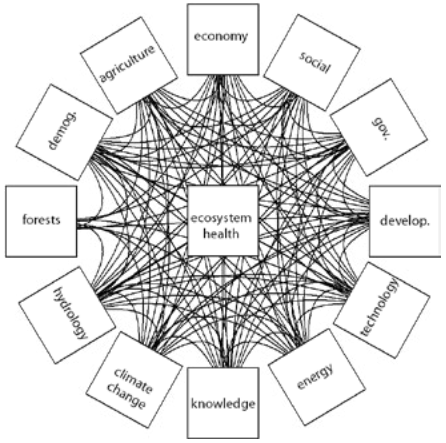
Jobs/economic

Timber town
Pulp mill
Boeing introduced manufacturing
Retaining of workforce
Emphasis on farming
Handful of fairy left from 100
Ag tourism + organic
Milk town
Naval station in Everett
Lack of private investment
Job creation
Cities taking job numbers and not housing numbers
Paine Field commercial (?)
2025 SeaTac runs out of space
Driving trade (getting on a plane)
Wealth creation economy (Boeing, Microsoft, Starbucks)
Circulating economy (restaurants, services, etc)
Airports and trade
Global port cities air travel access
Competitiveness
Fly into SeaTac for meetings
21st largest Korean population
Economy
Jobs
Transportation
Population growth
Trade and port activities
I-90 capacity
Rail and stampede
Panama Canal expansion (30% out of Everett)
Canadian alignment with rail and port
70% of goods end up in Midwest

Overarching Conceptual Models Synthesized from Focus Group Meetings and Interviews

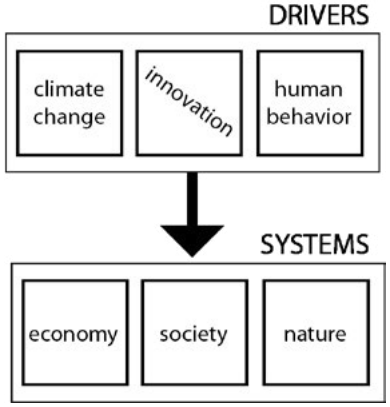
Networks (Centered on Focal Issue)

- Everything is connected to everything
- Functional groupings or sectors divide the world
- At the center is the focal issue, goal or problem



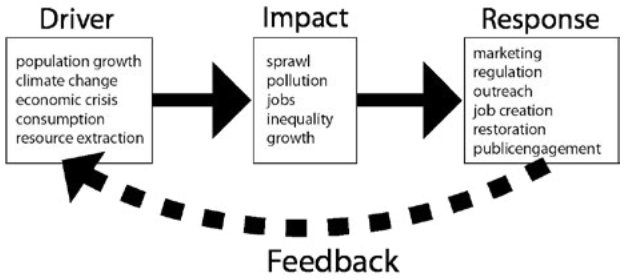
Directional (Driver - Systems)

- Drivers force changes in systems
- Systems formulated around either human and natural forms or social, economic and natural systems
- Hierarchy defined by time, space or discipline.



Dynamic (Driver, Impact, Response, Feedback)

- Human and natural created drivers cause change in the environment
- Impacts are characterized by changes in the patterns and processes we observe
- Feedbacks may link back from responses to influence (lessen or increase) the drivers.



Modifications

Time: past, current or future activities

Scale: Drivers operate at multiple levels

ie. global, national, regional, local

Uncertainty: knowledge limitations regarding the future

Risk: How uncertainty modifies human behavior and decisions

Assessment: Methods, data and conclusions characterizing current conditions and management

Indirect relationships: Influence modulated through components of the model

ie. impacts of climate change on environment are modulated through human activities

Conceptual Model Workshop

Date(s)

11.12.2010

Location

Graham Visitors Center. UW Seattle.

Objective

Develop a shared conceptual model to define the problems that the Snohomish River Basin will face over the next 50 years. Specifically the conceptual model will help the project team to identify the key driving forces that will shape the future of the Basin and explore their relationships and potential interactions.

Attendance

29 members of the Science Team representing acadmic, profession and non-profit organizations around the region including NOAA, City of Everett, King and Snohomish Counties, SPU, Wild Fish Conservancy, NW Power and Conservation Council, WA DNR and DOE, WA Emergency Mngt, American Farmland Trust, Tulalip Tribes, UW Public Affairs, Civil Engineering, College of Built Environments and College of the Environment.

Agenda

- Presentation of past syntheses and workshop activities
- Development of conceptual model teams
- Discussion and synthesis

Materials

Presentation (see pages A6.28-33)

Workshop Instructions Packet (A6.34-38)

What will be Snohomish Basin's Future?

How will the basin develop? Will agriculture disappear or prosper? Will high tech grow? Will salmon thrive? Will water be clean? Will there be enough for all users?

Conceptual Model Workshop

Snohomish 2060 Scenarios

Developing one shared story to characterize the Basin's plausible futures

Friday Nov 12, 2010

Graham's Visitors Center, Washington Arboretum, Seattle WA

Thank you for coming

Abby Hook
Al McGuire
Alan Berning
Alan Hamlet
Amy Snover
Andrew Stout
Andy Haus
Ann Bostrom
Ann Bylin
Anna Miles
Anne Vernez Moudon
Barbara Mock
Bill Beyers
Bill Knutson
Bob Bilby
Bobbi Lindemulder
Bonnie Geers
Branden Born
Brent Lackey
Brett Swift
Chris Bitter
Chris Raezer
Cindy Spiry
Clark Williams Derry
Daryl Williams
Dave Kaseluk
Dave Montgomery
Dave Peterson
Dave Redman
David Batker
David Buerge
David Burger
David Dilgard
David Remlinger
David Somers
Deborah Knutson
Denise Pranger
Dennis Lettenmaier
Dom Amor
Don Stuart
Doug McLelland
Elaine Babby
Elizabeth Walker
Elizabeth Weldin
Heidi Bohan
Heike Mayer
Hendrik Wolf
Howard Schwartz
Jackie Aitchinson
Jacque Klug
Jan Henderson
Janne Kaje
Jim Miller
Jim Teverbaugh
Joe Tovar
John Findlay
John Gamon
John Moore
John Postema
John Ufford
Judy Herring
Karen Kinney
Kathy Wolfe
Kelly Heintz
Ken Yocom
Ken Zwieg
Kollin Higgins
Krista Bartz
Kristin Kelly
Kurt Burdslee
Linda Nuenzig
Luke Rogers
Marcia Meyers
Mark Boyar
Mark Maureen
Mark Simonson
Mary Embleton
Matt Mattson
Matt Wiley
Michael Blake
Michael Kern
Mike March
Mike Pattison
Mike Town
Morgan Schneidler
Nick Bratton
Norm Abbott
Patrick Pierce
Paul Crane
Peter Jackson
Philip Popoff
Ralph Svrjcek
Richard White
Robin Lesher
Ryan Hembree
Sandra Mallory
Sara Curran
Scott Moore
Scott Powell
Scott Powers
Sim Larkin
Simon Geerlofs
Stacy Trussler
Stanley Aash
Stephen Stanley
Stewart Matthiesen
Sue Ambler
Terry Williams
Tim Walls
Thomas Payant
Tom Leschine
Tom O'Keefe
Troy Hall
Yi Zhao

Marina Alberti
Blake Trask
Karis Puruncajas
Michal Russo
Elisabeth Larson
Tracy Fuentes

UERL TEAM

Agenda

8:45-9:30	Presentation
9:30-11:00	Teams develop Conceptual Model
11:00-11:30	Teams Present
11:30-12:00	Discussion
12:00-12:30	Lunch
12:30-1:00	Synthesis Discussion

Today's objective

Develop a shared conceptual model, or framework, that defines the challenges and opportunities that the Snohomish River Basin will face over the next 50 years.

introduction | synthesis | action

Scenarios for Snohomish Basin 2060

Develop an assessment of key ecosystem services in the Snohomish Basin by characterizing the uncertainty associated with alternative future baseline conditions.

.

a 2-year research agenda

Funded by the Bullitt Foundation

introduction | synthesis | action

Snohomish 2060 Scenario project

Project Objective:

- *develop a synthesis of what we know*
- *integrate diverse perspectives*
- *challenge assumptions about the future*
- *inform development of management strategies*

introduction | synthesis | action

78 interviews **3,542 keywords** **36 conceptual models**

developing one shared story

Project TIMELINE

Meetings & *Interviews*

2010

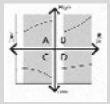
- Winter
- Spring — Kickoff
- Summer — *Driving Forces*
- Fall — **Conceptual Model Workshop**

2011

- Winter — Scenario Logics Workshop; *Scenario Development*
- Spring — *Computational Model*; Integrated Model Workshop
- Summer — *Policy options*
- Fall — Policy Workshop; *Evaluation criteria*

Snohomish 2060 Scenario project

Approach:
Instead of focusing on a single prediction, we use Scenario Planning to explore alternative plausible futures and highlight the risks and opportunities involved in strategic decisions for the basin development.



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Alternative Future Approaches

Predictive modeling

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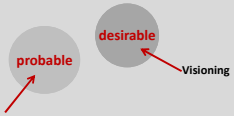
Alternative Future Approaches



Predictive modeling

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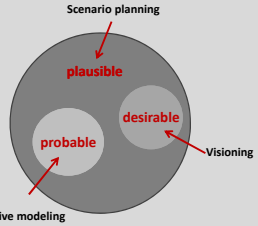
Alternative Future Approaches



Predictive modeling

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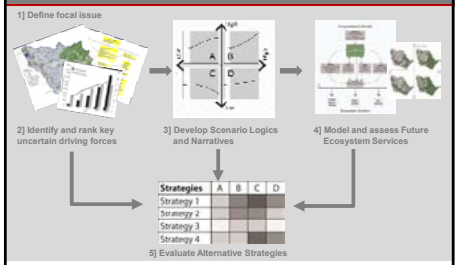
Key elements of scenario planning



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Key elements of scenario planning

1. **Define focal issue**
   - Data and observations
   - Historical documents
   - Expert knowledge
   - Conceptual models

↓ OBJECTIVE:
Develop a shared problem definition

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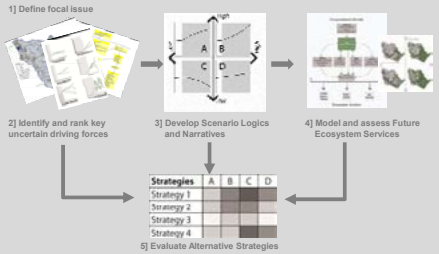
Key elements of scenario planning



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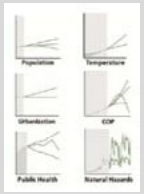
Key elements of scenario planning

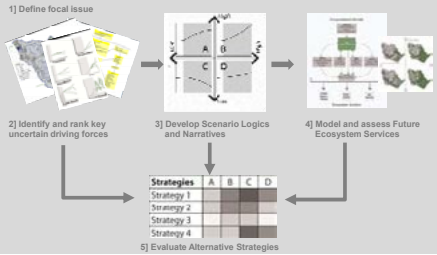


2. **Identify and rank driving forces**
   - Identify key driving force
   - Rank their importance
   - Rank their uncertainty
   - Select most important & uncertain

↓ OBJECTIVE:
To capture the most divergent yet plausible futures

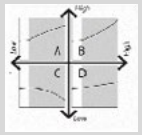
introduction | synthesis | action

Key elements of scenario planning



introduction | synthesis | action

Key elements of scenario planning



3. Develop scenario logics and narratives

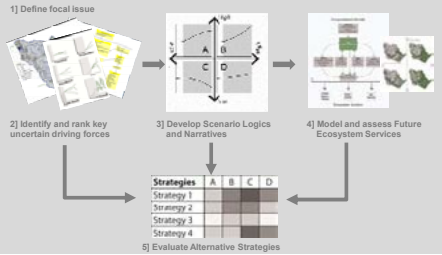
- Selected driving forces create the frames for scenario logics
- Participants develop the story lines and narratives

↓ **OBJECTIVE:**

The outcome are four distinct stories of how the future can unfold

introduction | synthesis | action

Key elements of scenario planning



introduction | synthesis | action

Key elements of scenario planning

4. Assess Impacts

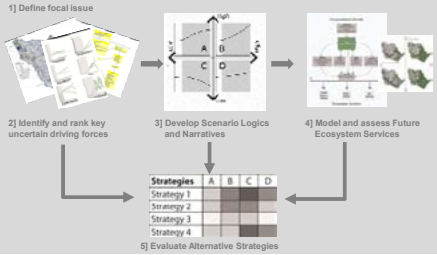
- Identify indicators
- Apply predictive models
- Assess impact of future conditions

↓ **OBJECTIVE:**

The is an assessment of future conditions

introduction | synthesis | action

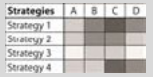
Key elements of scenario planning



introduction | synthesis | action

Key elements of scenario planning

5. Evaluate alternative strategies



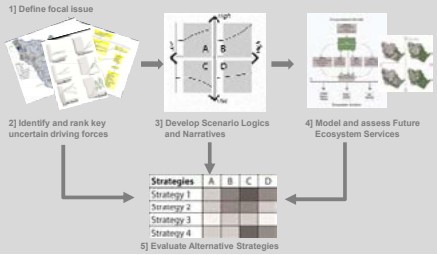
- **Use indicators to evaluate alternative strategies (their efficacy and robustness) under alternative scenarios.**

↓ **OBJECTIVE:**

The is an evaluation of alternative strategies

introduction | synthesis | action

Key elements of scenario planning



introduction | synthesis | action

The Basin

25 miles Northeast of Seattle
446,476 people
170,000 employees
1,190,000 acres
60% forested

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Interviews and Focus Groups
Recurrent themes
Keywords
Conceptual Models

SYNTHESIS

develop one shared story through one conceptual model

Rationale:

- Explore different perspectives
- Create a shared view of the problem
- Identify multiple driving forces before selecting the most critical and uncertain
- Explore potential relationships between drivers
- Understand areas of agreement and disagreement.

introduction | synthesis | action

Building a Conceptual Model:
What we have done so far

- Identified over 120 experts representing 100 agencies, departments and Tribes
- Conducted 78 interviews with experts and focus groups
- Recorded 60 + hours of your story

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Building a Conceptual model:
Survey Instrument

1. ***Stories***
   We asked
   What are some fundamental differences between the Puget Sound in 1960 and today?
   What do you believe will be the fundamental differences between the Basin today and in 2060?
2. ***Keywords and Categories***
   We asked to group and title keywords
3. ***Conceptual models***
   We asked you to link categories with arrows

introduction | synthesis | action

Building a Conceptual model:
What we did*: interviews and focus groups*

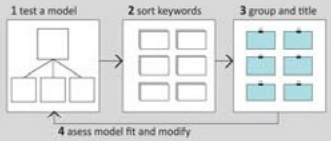
Your input:

- Dozens of narrated anecdotes, personal experiences and unique perspectives
- Over 3,000 isolated keywords (post it notes)
- 36 conceptual models



introduction | synthesis | action

Today's Instructions

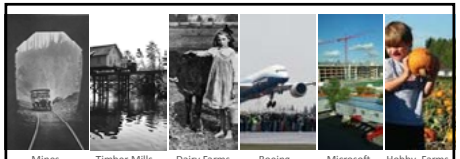


introduction | synthesis | action

Stories: Three recurrent interview themes

1. **Change in industry** *with cascading changes to demography, settlement patterns and natural resources extraction.*
2. **Change in values** *with cascading changes to how we regulate, what we invest in and how we market ourselves*
3. **Environmental Assessment** *with cascading changes to information access, what we bring into decision making (scale and actors) and our risk assessment.*

introduction | synthesis | action



Mines | Timber Mills | Dairy Farms | Boeing | Microsoft | Hobby Farms

CHANGE IN INDUSTRY

City of Smokestacks
Evergreen State
All American City

CHANGE IN VALUES

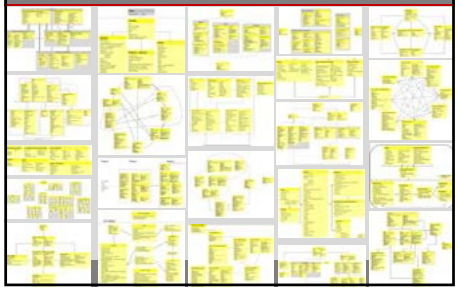
Endless bounty of Pacific Northwest
Earth Day 1970
ESA + Spotted Owl vs Timber
Sprawl and Streams (non-point pollution)
Global warming

ENVIRONMENTAL ASSESSMENT

78 interviews 3,542 keywords 36 conceptual models

developing one shared story

Comparing conceptual models



Comparison of conceptual models

No best model,
just different perspectives

Comparison of Overarching Models

Major differences

- **Groupings:** organized by functionality, sectors, (sub)systems
- **Hierarchical organization:** *i.e. national, regional and local drivers*
- **Representation of actors:** description of agents, their role and action, operating within the basin
- **Magnitude of relationships:** even weight to connections or tight and loose couplings
- **Feedbacks:** Inclusion of the feedbacks between responses, conditions and drivers

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Comparison of Overarching Models

Major similarities:

- Characterization of the **focal issue(s)**
- Illustration of the **complexity** of the relationships within the system
- Include the interplay between the **human** (social, economic) **and the natural system**

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Overarching conceptual models

You created 36 unique conceptual models.

Understanding the differences and similarities can help us bridge together one shared model.

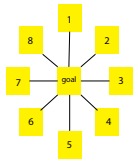
Looking at them side by side, we saw 3 overarching conceptual models repeated with distinctive variations and hybridizations:

Networks **Directional** **Dynamic**

introduction | synthesis | action

Networks (Centered on Focal Issue)

abstract



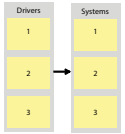
example

Highlights

- At the center is the focal issue, goal or problem
- Everything is connected to everything
- Functional groupings or sectors divide the world

Directional (Driver - Systems)

abstract



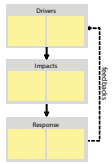
example

Highlights

- Drivers force changes in systems
- Systems formulated around either human and natural forms or social, economic and natural systems
- Hierarchy defined by time, space or discipline.

Dynamic (Driver, Impact, Response, Feedback)

abstract



example

Highlights

- Human and natural drivers cause change in the environment
- Impacts are characterized by changes in the patterns and processes we observe
- Human and natural systems respond to impacts
- Feedbacks influence the drivers.

Variations and Hybrids

Time: past, current or future activities

Scale: Drivers operate at multiple levels

ie. global, national, regional, local

Uncertainty: knowledge limitations regarding the future

Risk: How uncertainty modifies human behavior and decisions

Assessment: Methods, data and conclusions characterizing current conditions and management

Indirect relationships: Influence modulated through components of the model

ie. impacts of climate change on environment are modulated through human activities

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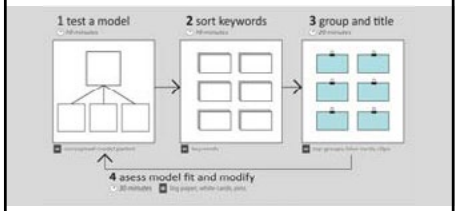
Today's exercise: building a shared conceptual model

one shared model

Team Time



introduction | synthesis | action

Roles

Moderator
Note taker
Timekeeper
Illustrator
Presenter

introduction | synthesis | action

What's on your table

- instructions packet
- conceptual model packet
- foam board with:
  - big paper
  - keywords
  - white and blue cards
  - 'jail'

introduction | synthesis | action

Example Final Model

introduction | synthesis | action

select overarching model
sort keywords
title and arrows
develop presentation

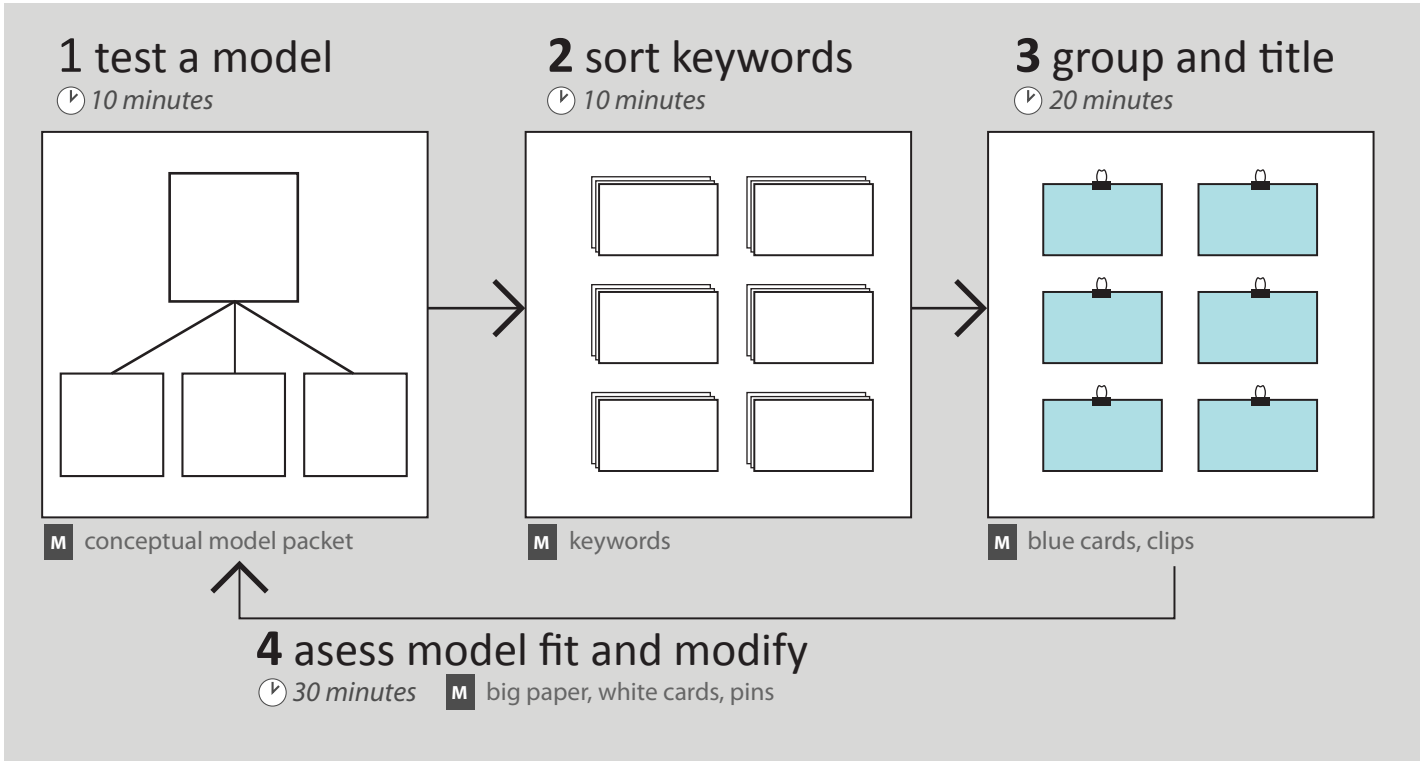
TEAM TIME

Conceptual Model Exercise

time M materials

0 role selection

10 minutes M roles packet



5 prepare presentation

10 minutes

Moderator

Role: Ensure everyone is being respected (heard and incorporated) and the conversation is on point and productive.

Instructions: Start by conducting a round of introductions, if not already done. Ask the table to set some ground rules. We suggest you start with the ones attached and ask team members to add any additional ones.

Tips: Try to keep everyone engaged while also ensuring the conversation focused. We understand that it can be very challenging to participate in the dialogue and to moderate simultaneously. Do make sure that your voice is being heard too and that the resulting model reflects everyone's input, including your own.

Ground Rules

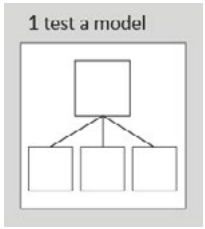
1. Be respectful of your team mates.
2. Do not talk over each other.
3. Contribute constructive criticisms (don't be negative or hurtful)
4. Stay on topic.
5. _____

Suggested moderator instructions and questions

9:30-9:40 Role selection

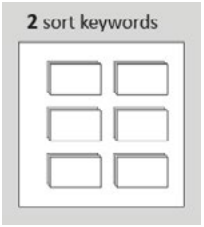
- Team members select and review individual team roles

9:40-9:50 TEST A MODEL



- Ask team:
  1. *Which, if any model they like best and why?*
  2. *Do they have any questions about any particular models?*
  3. *Are there any models that really surprise them (or don't make sense to them)?*
  4. *Do they see the solution as more of a hybrid of multiple models?*
  5. *Which model, or 'hybrid', would they like to test out today?*
- If the majority of people are going with one while 1 or 2 people want another, have the minority representatives explain what they don't like about the 'majority' model that the 'minority' model does better. Ask team:
  1. *Is there is a way to combine the critical components of the two (or three) models together?*
  2. *Is everyone comfortable with testing out their 'hybrid' and checking back in 45 minutes to see how to amend it?*

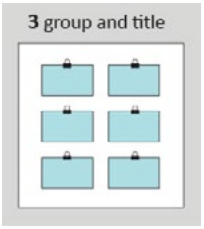
9:50-10:00 SORT KEYWORDS



- Give each member a fifth of the pile and ask them to create groups. If they are stuck on a keyword or think it is unimportant they can put it in the 'Jail' pile. If anyone is done early, feel free to look through and sort the Jail pile.

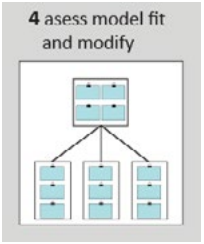
10:00-10:20 GROUP AND TITLE

- As a table, go through team member's groups and have them describe what is in each stack and give each stack a temporary title.
- Have other team members add their groups if similar. Revise titles as appropriate.
- After going around the whole table, have team decide on selection of groups and their titles. Let them know there will be another chance to revise these.



10:20-10:10:50 Assess Fit and Modify

- Have team try to place each group within a box of your overarching conceptual model (that your illustrator drew).
- Discuss:
  1. How well do the groups fit within the boxes?
  2. Does this model make sense? Is this model still the best fit (out of the three)?
  3. How should it be revised? Is there a potential hybrid model? Should we add additional boxes? Variables? Arrows?
  4. Is there anything really missing or misrepresented in the model
- Remind note taker to record successful solutions and unresolved challenges
- Have illustrator revise the conceptual model to incorporate changes.
- Place clipped groups within revised team model. Discuss:
  1. *Are there any obvious subgroups that need to be formed? Sort, clip and provide titles.*
  2. *Are there any important keywords missing from any groups? Fill in new white cards*
  3. *Are there any cards that may belong under multiple headings?* How should they be handled (create duplicates? draw arrows? Create new subgroup?)
- Ask Team:
  1. *Look at final model. Ask everyone what are they most happy with? What would they still like to see resolved?*
- Finalize conceptual model. Have illustrator 'finalize' model by drawing in final lines and boxes, titling everything and then clipping and pinning the keywords in their groups.



10:50-11: 00 Prepare presentation

- Presenter tests out his/her presentation

NOTE TAKER

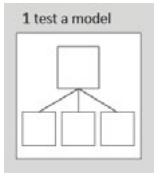
Role: Keep track of discussion, especially ideas that don't fit well into the preconceived products.

Instructions: Shorthand conversation topics and points of disagreement or discussion. You do not need to script verbatim, nor include who said what. Check in with team mates regularly to ensure you captured their ideas correctly. You do not need to duplicate the model or keywords aggregation as the illustrator will take care of this.

Materials: suggested discussion notes, pad of paper, pen and pencil.

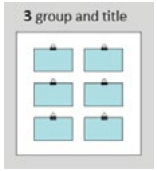
Suggested discussion notes

1. **TEST A MODEL**
   - Benefits and limitations of specific overarching models
   - Questions about particular models
   - Models that surprise, why?
   - Potential hybrid solutions

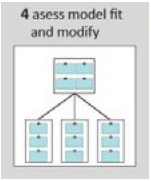


2. **Sort keywords**

3. **GROUP AND TITLE**
   - List merged groupings (*Example: Demography -> Population -> (final) Society)*



4. **ASSESS FIT AND MODIFY**
   - Do the groups fit in the overarching model? Why?
   - Does the model make sense?
   - Model revisions?
   - Anything missing from model? Anything misrepresented?
   - What are people most happy with?
   - What would they still like resolved?



5. **Prepare presentation**

TIME KEEPER

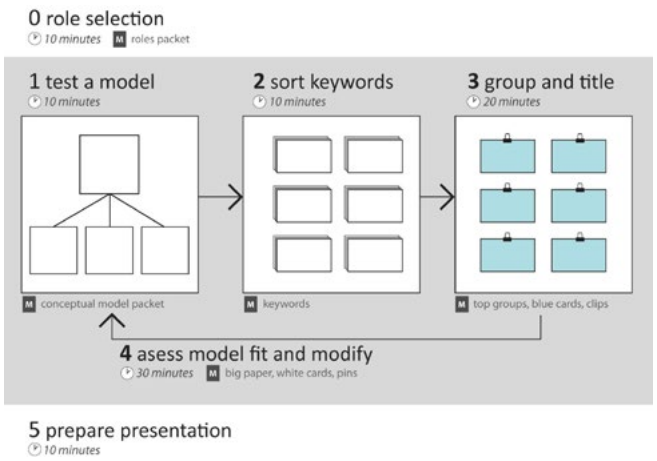
Role: Ensure team accomplishes all 4 steps in the time allocated by keeping track of time and informing team of time how much time is left.

Instructions: Not all workshop teams will follow the exact same time table. Some teams will take longer to accomplish step 1 and then breeze through the rest, others will follow exactly the schedule suggestion we have provided. It is up to you to decide whether you want to adhere strictly to the schedule or to let your team deviate as need be. When you feel it is time to move on, please be respectful of whoever is talking, wait until they are done (or paused) and let them know it is time to move on to the next task. If the discussion lingers, reiterate how much time is left and what tasks still need to be accomplished.

Materials:

Available time piece: if you do not have a reliable time piece available to you, raise your hand and we will supply you with one. In addition, there is a countdown projected on the northern wall of the room (it will reach zero at 11:00am)

Schedule suggestion:

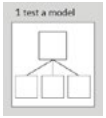


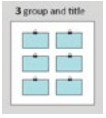
ILLUSTRATOR

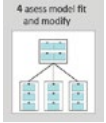
Role: Assist team in creating a legible and coherent model by drawing, writing, stacking, clipping, etc (you can let others draw too).

Materials: Foam board, marker, pen, scratch paper, 120 keywords, 20 blank white flashcards, 20 blank blue flashcards, binder clips, pins.

Suggested Instructions: *Draw conceptual model (f*or a view of what the finished model looks like see attached photo, or look at the prototype at the front of the room (by speaker)). Remember to check with teammates often to ensure you are representing their ideas accurately.







1. TEST A MODEL

Sketch the overarching model / hybrid model your team selects; draw in boxes, arrows and titles as necessary. Do not just duplicate what's on the template, but rather incorporate specific team ideas.

2. Sort keywords

3. GROUP AND TITLE

Write group titles on blue cards. As new group titles emerge, just cross out the old ones and write the new on the same card.

Clip together each group.

4. ASSESS FIT AND MODIFY

Revise model to incorporate additional boxes, names, arrows and variables.

Ask team members if you are representing their ideas correctly.

5. PREPARE PRESENTATION

Redraw model (if necessary) to incorporate all final changes

Pin to foam board

Rewrite (if necessary) blue group cards

Pin clips inside appropriate boxes

Stand on easel

PRESENTER

Role: Succinctly represent your team's model to the rest of the workshop.

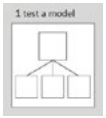
Instructions: Review the 'template' and example narrative (included below). Please keep in mind your will have 5 minutes to present a focused account of your team's model. While participating in the development of the model, keep notes on critical ideas you will want to present. Specifically, highlight unique features and unresolved challenges. During the last ten minutes of the exercise fill in the template and check in with your team mates to ensure you are representing the model accurately. When presenting, focus on the overall narrative of your model and critical features, see example below. Please note, to ensure all teams have time to present; we will stop you after 5 minutes.

Template: *[things to be mindful of when preparing your presentation]*

0. ROLE SELECTION

Your team: "Name" and team members

1. TEST A MODEL



Selected overarching model

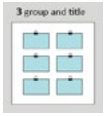
Major modifications / hybridization of overarching model

2. Sort keywords

3. GROUP AND TITLE

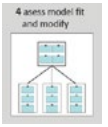
Titles of groupings / sub-groupings

If important to explain overall story, name a few keywords in each group or special groups



If important, location of groupings / proximity to other groups

4. Assess Fit and Modify



Description of arrows (directionality, importance, feedbacks, positive / negative influence)

Special features / variations / additional dimensions etc. *For example, adding uncertainty as an overarching driver, or ecosystem services as an output.*

Highlights

one or two important strengths of the model that you want to underscore

one unresolved challenge, that you hope the final shared conceptual model could address better.

Example: We are Team A and include Anna, John, Frank and Elizabeth. Our model is based largely off the 'directional' model but add in a third dimension of time. Our global drivers are climate change, technology and the economy and they influence regional drivers including human perceptions, demographics, regulations, and natural resources. These regional drivers influence more localized systems including development [market and form], timber, agriculture, hydrology, ecosystem functions [biodiversity and habitat] preferences and values, funding availability, and social services. As you can see, as you move down the scale becomes smaller (global to local). Not well represented here is the third dimension, of time, so the 'deeper' you look into the page the further back in time you go. And these stories and legacies influence the picture of the system today. The arrows pushing down are the most influential but arrows going up reflect cumulative feedbacks. The interactions between individual systems and drivers are also important, especially at specific time and spatial scales. We all like that the model clearly represents time and space and the hierarchy of drivers. What we wish we had more time to explore is the finer interactions between drivers and systems, those elements that don't neatly fit into one box or another. For example, the issue of salmon and agriculture coexisting in floodplains brings together several boxes in a unique way that isn't immediately obvious from just looking at the model, but is really important to us. It's almost like if we want to represent special issues or decision points along both the time and space continuum in an elevated manner.

Syntheses

At the Conceptual Model Workshop, Science Team members provided aggregate models and guiding directives on what the shared conceptual model should include and how it should be represented. Moving forward, we took the 6 team models and combined them into one shared model.

The most significant challenge highlighted during the workshop was balancing a dynamic model including various relationships and feedbacks with a parsimonious and clear model that can be communicated effectively.

Further challenges included how to traverse scales, how to validate the model and how to reflect uncertainty and risk. In addition, participants wanted the model to express the role of various stakeholders while highlighting the decision making process including assessments, strategies and current gaps. A process related challenge was how will the UERL will interpret team models and incorporate various levels of feedback from participants.

Workshop Directives (for building a model)

1. Have **clarity**: Easily understood and communicated. Well organized. Clear purpose. Captured at a glance. Transparent.

2. Be **parsimonious**: Balance complexity and simplicity (of relationships)

3. Traverse **scale**: Be relevant at local scale. Include exogenous factors. Keep Basin in mind.

4. Reflect **actors**: Stakeholders and decision makers should see themselves in the model

5. Be **dynamic**: Relationships occur on many levels. Not linear or mechanistic. Show feedbacks and impacts. Reflect interdependence and linkages. Ordered processes and indirect relationships should be traceable.

6. Cite **validation**: Include references. Claims should be validated consistently. Multiple audiences and inputs. Defend relationships and feasibility.

7. Quantify **impacts**: Depict strong relationships. Express multiple relationships. Incorporate feedbacks. Show relative importance of drivers. Evaluation criteria should be explicit.

8. Highlight **uncertainty**: Focus on uncertainty. Incorporate risks and resilience.

9. Link to **measurements**: Characterization, indicators, metrics or system assessment should be expressed.

10. Express **decision making**: Highlight gaps in knowledge and strategies. Reflect who is decision makers. Linkages to goals and absence of policy.

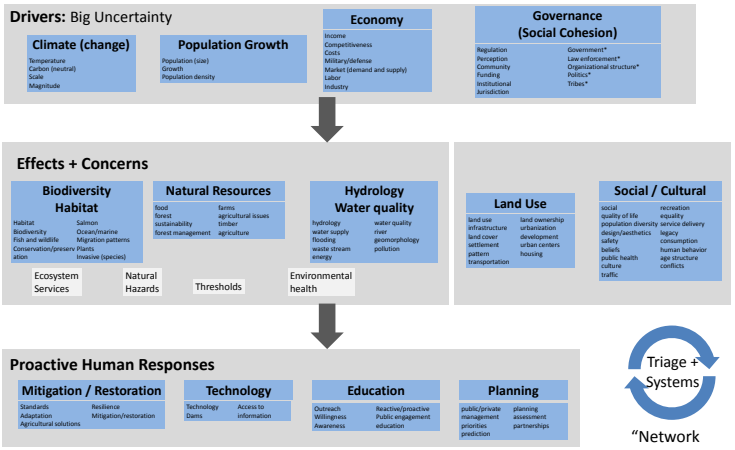
11. Incorporate **time**: Legacies and baselines inform future condition. Functional considerations, like time, influence model. Legacies inform econometric model.

12. Be **organized**: Add systems between drivers and impacts. Divide by environmental, social and economic groups or human / natural. Include governance as driver. Include both important and 'stray' drivers. Include social and human dimensions, economic (growth, development, commercial, industry) and legal constraints

13. Synthesize **intersections**: The combination of multiple drivers, systems and / or impacts is what makes this study compelling

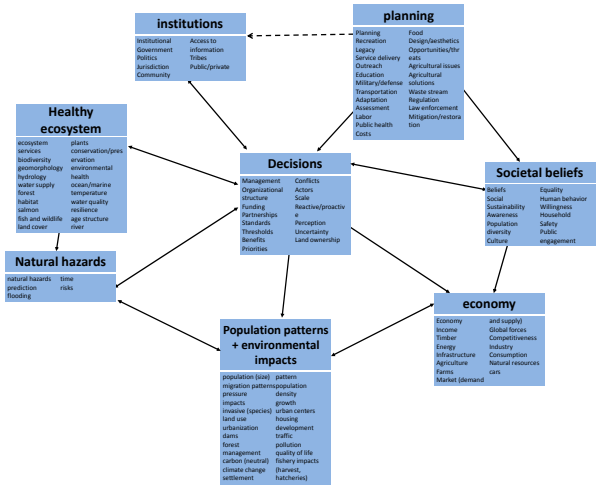
6 Team Conceptual Models

Team 1

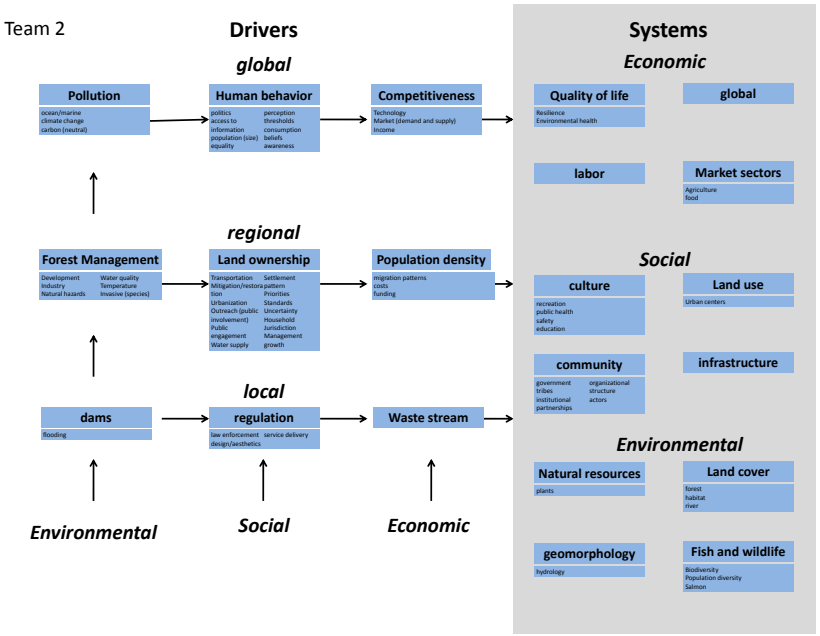


* These cards were grouped together and turned in opposition within the stack. I am not sure if that is by chance, or two intentional subgroups.

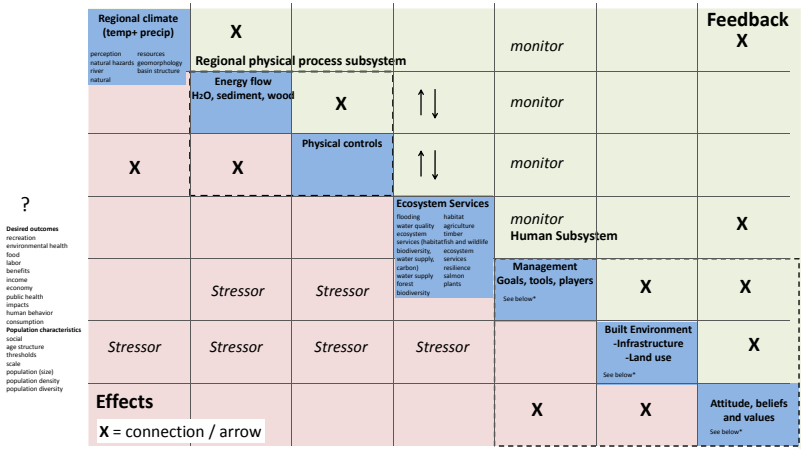
Team 3



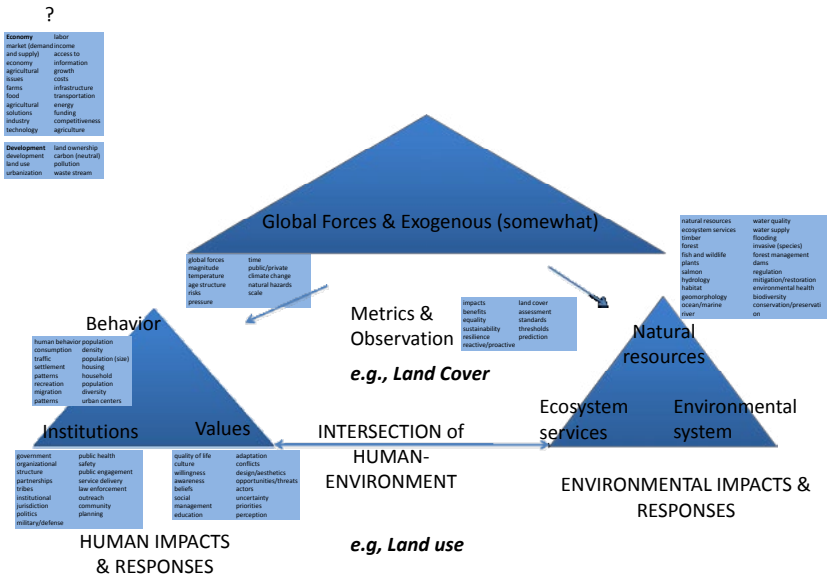
Team 2



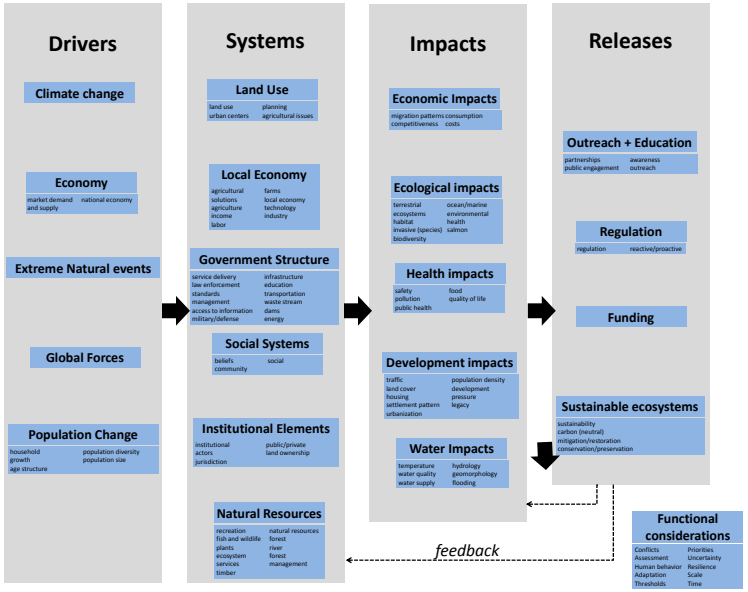
Team 4



Team 5



Team 6



List of 14 Drivers, their overarching categories and sub-drivers

HUMAN

Behavior
- Adaptation
- Consumption
- Interaction with nature
- Investments

Demography
- Characteristics
- Growth
- Health

Values
- Belief
- Preference
- Perception

INSTITUTIONS
- Economy
- Funding
- Industry
- Labor
- Market
- Wealth

Governance
- Politics
- Planning and Regulation
- Services

Knowledge
- Innovation
- Science
- Outreach

Social Institutions
- Community
- Culture
- Tribes
- The World
- Public engagement
- Organizations

BUILT ENVIRONMENT

Development
- Character
- Form
- Land Use
- Municipalities
- Real Estate

Infrastructure
- Energy
- Flood Mitigation
- Transportation
- Waste stream
- Water provision

Resource Management
- Agriculture
- Forestry
- Recreation and Fishing

NATURAL ENVIRONMENT

Biogeochemistry
- Chemicals and Nutrients
- Landscape Movement
- Seismic
- Soils and Minerals

Climate
- Air Quality
- Carbon
- Natural Cycles
- Global Change
- Ocean Acidification
- Precipitation
- Sea Level Rise
- Snow Pack
- Temperature

Hydrology
- Flooding
- Groundwater
- Hydrograph
- Morphology
- Stormwater
- The Watershed
- Water Quality
- Water Quantity

Terrestrial Biosphere
- Biodiversity
- Estuaries
- Fire
- Forest Habitat
- Pests and Invasive Species
- Salmon and Stream Habitat

Driving Forces Working Papers

Working documents are internal reports created through the scenario development process. Working documents are the emergent and collaborative product of interviews with the Science Team. Working documents are living documents, meaning they are constantly being updated and revised through input.

Driving forces, or drivers, are the main ingredients of scenario planning, describing factors or phenomena which alter the future trajectory in significant ways. Examples of driving forces include demographics, climate change and governance. Identifying and researching driving forces allows us to be explicit about the assumptions we make under each scenario.

On pages A6.42-63 we include emergent definitions and themes for the 14 driving forces as well as a sampling of published data describing current conditions, and past and future trends. In the following sections we further describe Science Team input describing the ***relationships*** between drivers, as well as the ***relevance, importance*** and ***uncertainty*** of each driver in the basin.

Behavior

Behavior represent individual action including physical alterations, interactions (with people and the environment) and where we put our money (consumption and investment). Social or group action is described under the overarching organization (ie economy, government, Tribes, community).

Adaptation is the ability to adjust to new information and experiences.

Consumption refers to the using up of goods and services by consumers. Consumption is also viewed as a basically subjective phenomenon, with individual utility, or satisfaction, assuming primary importance.

Human environmental interaction refers to how we affect and are affected by the environment, and also how we disturb the natural environment.

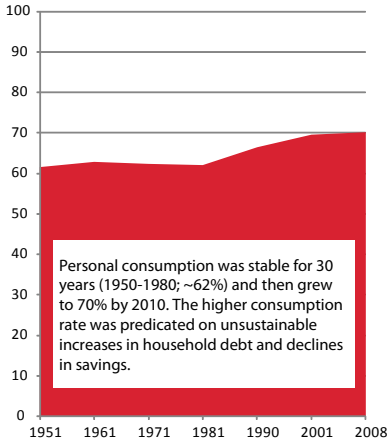
An **investment** involves the choice by an individual or an organization, to commit money to the purchase of assets for the possibility of generating returns over a period of time, but with the awareness of a certain level of risk. It is related to saving or deferring consumption.

One common measure of consumption is personal consumption expenditures (PCE) which includes new goods and services purchased by individuals (measured by US Dept of Commerce) the second is Consumer expenditure survey (measured by the Bureau of Labor Statistics) which are diaries of frequently purchased items and regularly billed items collected from sample households .

While the last decade was termed an 'orgy of consumption' the Brookings Institute predicts the US will settle into a new era of lower consumption as a share of GDP after the economic crisis of '07-'09. Businesses will shift towards more exports and abroad countries will shift towards domestic consumption. The uncertainty lies not in the direction of change (towards lower $ in consumption) but rather in the magnitude.

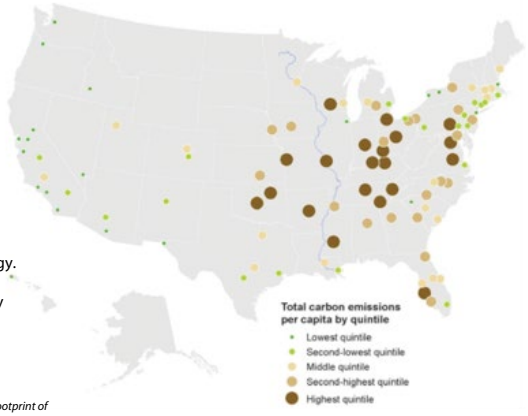
Galston, W.A. 09.01.08. The "New Normal" For the U.S. Economy: What Will It Be? The Brookings Institute.

US Personal consumption as a % of GDP



Smallest Carbon Footprints (out of 100 metro areas)

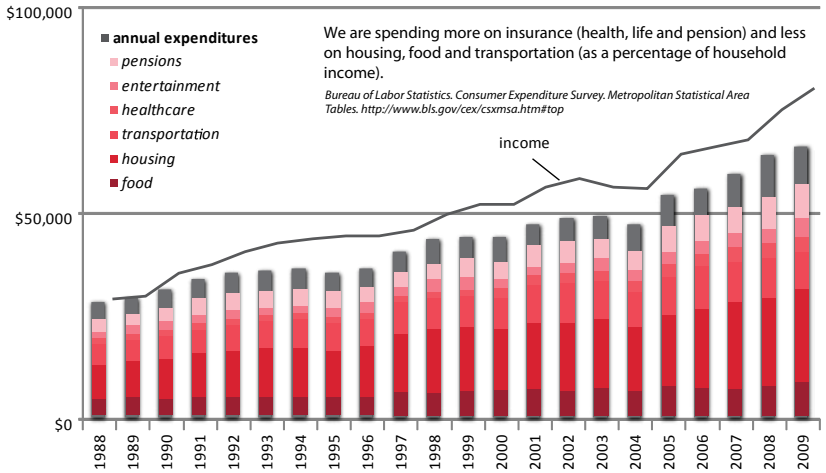
1	Honolulu, HI
2	Los Angeles, CA
3	Portland, OR
4	New YorK, NY
5	Boise City, ID
6	Seattle, WA
7	San Jose, CA
8	San Francisco, CA
9	El Paso, TX
10	San Diego, CA



Seattle has a low carbon footprint due its reliance on hydropower energy. Per capita carbon emissions from transportation and residential energy use for 2005 were 1.5 metric tons (a decrease of 4.4% from 2000, a time when the nation's footprint rose by 2.2%).

Sarzynski, A. et al. 05.29.08. Shrinking the Carbon Footprint of Metropolitan America. The Brookings Institute. http://www.brookings.edu/~/media/Files/rc/reports/2008/05_carbon_footprint_sarzynski/carbonfootprint_report.pdf

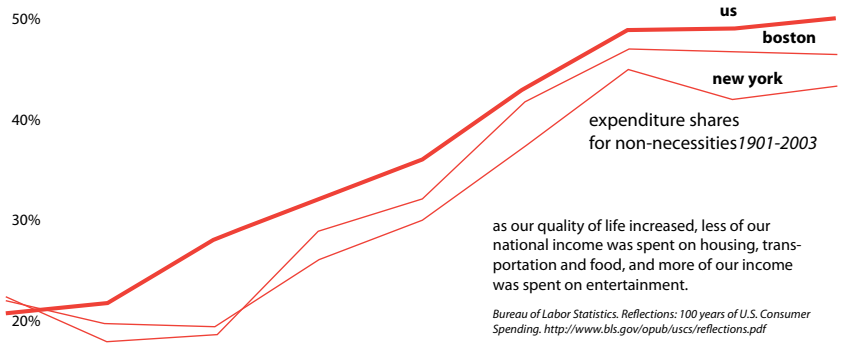
Consumer Expenditure Survey - Seattle Metropolitan Area 1988-2009



We are spending more on insurance (health, life and pension) and less on housing, food and transportation (as a percentage of household income).

Bureau of Labor Statistics. Consumer Expenditure Survey. Metropolitan Statistical Area Tables. http://www.bls.gov/cex/csxmsa.htm#top

Behavior *published data*



as our quality of life increased, less of our national income was spent on housing, transportation and food, and more of our income was spent on entertainment.

Bureau of Labor Statistics. Reflections: 100 years of U.S. Consumer Spending. http://www.bls.gov/opub/uscs/reflections.pdf

Behavior *published data*

Demography

Demography is the study of human populations including the size, structure and distribution of the population, and changes associated with birth, migration, aging and death.

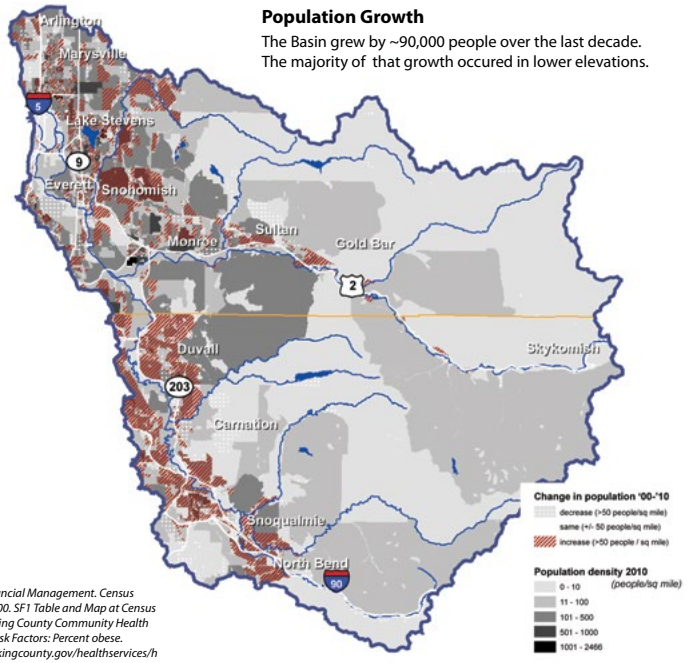
Characteristics refer to attributes that describe the population including age structure, diversity, educational attainment, households and income.

Growth refers to the change in the number of people residing in the Basin. Population growth stems from both migration (in and out) and natural increase (birth rates and mortality).

Health is the state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Public health is the study of prevention through surveillance of cases and promotion of healthy behaviors .

Population Growth

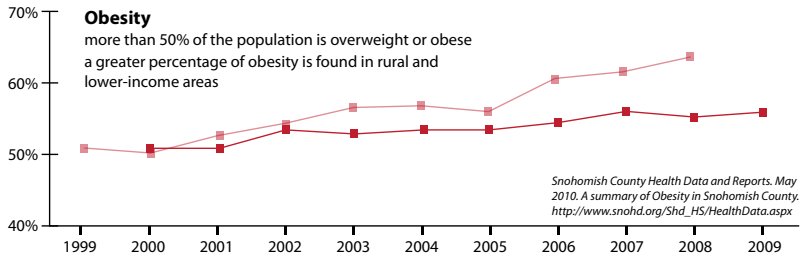
The Basin grew by ~90,000 people over the last decade.
The majority of that growth occured in lower elevations.



Office of Financial Management. Census 2010 and 2000. SF1 Table and Map at Census Block level. King County Community Health Indicators. Risk Factors: Percent obese. http://www.kingcounty.gov/healthservices/health/data/chi2009.aspx

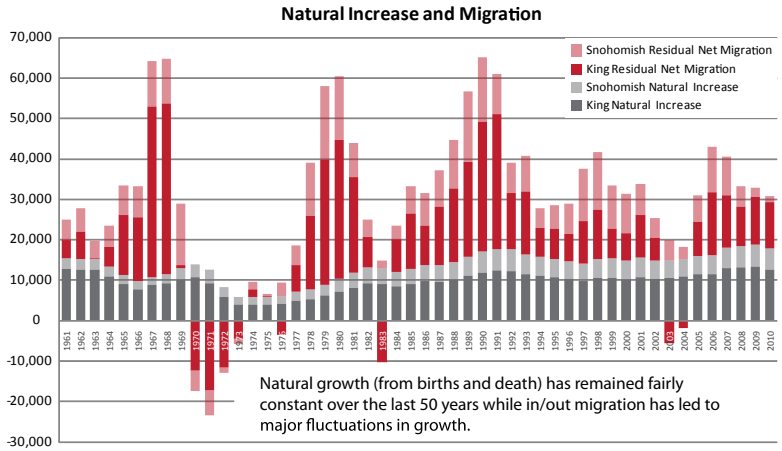
Obesity

more than 50% of the population is overweight or obese
a greater percentage of obesity is found in rural and lower-income areas

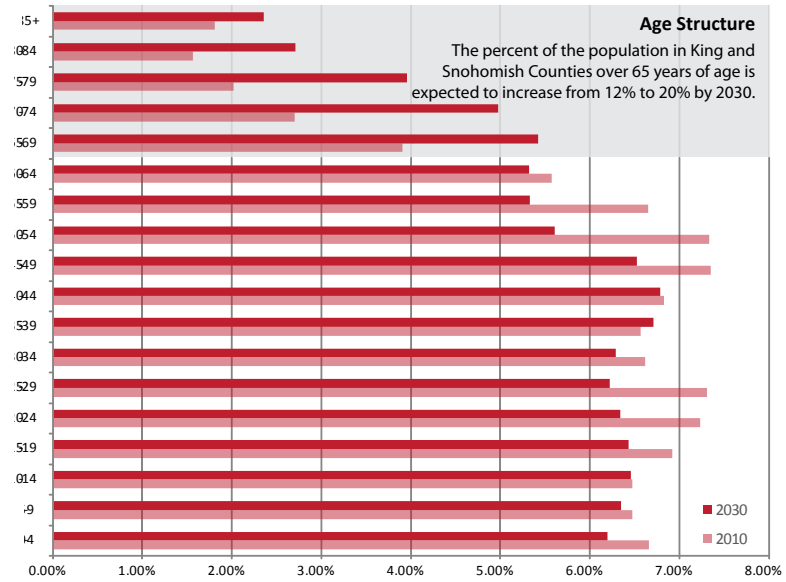


Snohomish County Health Data and Reports. May 2010. A summary of Obesity in Snohomish County. http://www.snohd.org/Shd_HS/HealthData.aspx

Demography *published data*



Office of Financial Management. July 2010. Migration: Population, population change, births, deaths and residual migration 1960 to 2010 by county by year.



Office of Financial Management. Projections by age, sex and race for the State of Washington: 2000-2030.

Demography *published data*

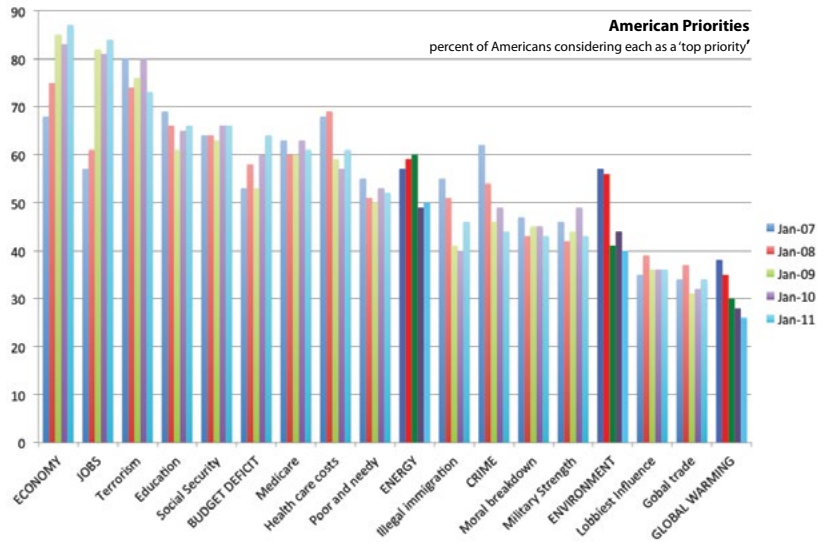
Values

Values are broad preferences concerning appropriate courses of action or outcomes. A value system is a set of subjective personal, varying across individuals and cultures. Values are generally aligned with beliefs and tend to influence attitudes and behavior.

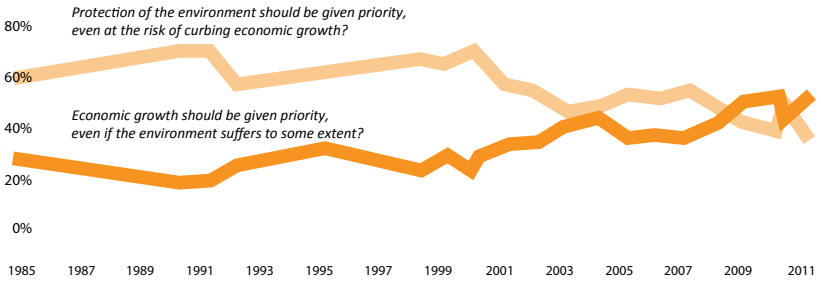
Belief is the psychological state in which an individual holds a proposition or premise to be true. Beliefs are described as ethics, consciousness, respect and faith.

Preferences reflect the priorities a population places on certain values. Closely associated with preferences are comments on quality of life and a willingness to act on certain values.

Perception is the process by which an organism attains awareness or understanding of its environment. Perceptions lead to what an individual or population perceives as acceptable or ideas about how things should be.



ecoAmerica. 2011. Trends in America's Climate and Environmental Attitudes: 2011: Summary results from recent major polls: Pew Research Center, Gallup, Rasmussen, Yale Project on Climate Change Communication.



ecoAmerica. 2011

Environmental Concerns
What are the environmental issues of our time (2011)

	Great deal/ Fair amount	Not much/ Not at all
Contamination of soil and water by toxic waste	79%	20%
Pollution of rivers, lakes, and reservoirs	79%	22%
Pollution of drinking water	77%	23%
Maintenance of the nation's supply of fresh water for household needs	75%	24%
Air pollution	72%	28%
Extinction of plant and animal species	64%	36%
The loss of tropical rain forests	63%	35%
Urban sprawl and loss of open spaces	57%	42%
Global warming	51%	48%

ecoAmerica. 2011

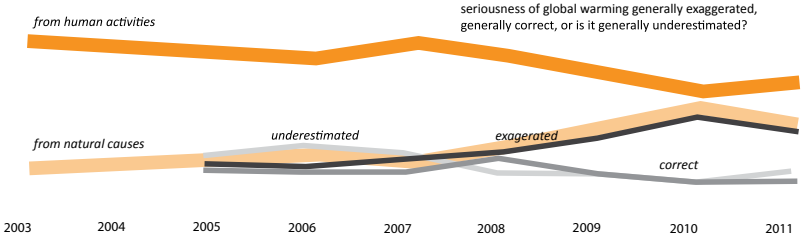
Perceptions

Is Climate Change man made? or natural?

Historically about 60% of Americans have believed that temperature changes on the planet are man-made. Over the past two years this has declined to just about half of the population.

Is Climate Change exagerated or underestimated?

Thinking about what is said in the news, in your view is the seriousness of global warming generally exaggerated, generally correct, or is it generally underestimated?



ecoAmerica. 2011

Values *published data*

Values *published data*

Economy

Economy refers to the production, distribution and consumption of goods and services. Economic growth is equated with profits, quantified by dollars earned.

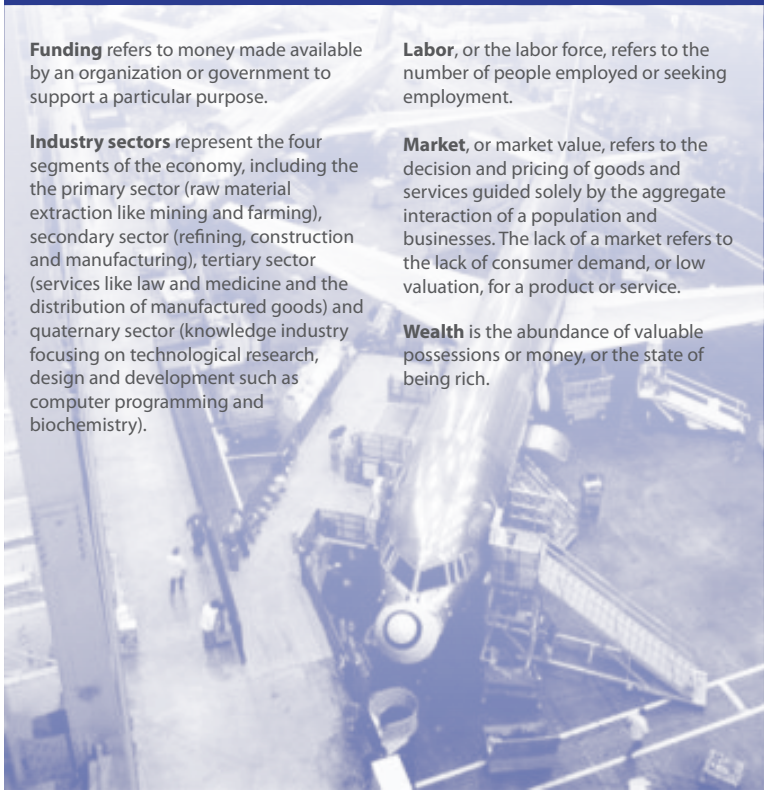
Funding refers to money made available by an organization or government to support a particular purpose.

Industry sectors represent the four segments of the economy, including the the primary sector (raw material extraction like mining and farming), secondary sector (refining, construction and manufacturing), tertiary sector (services like law and medicine and the distribution of manufactured goods) and quaternary sector (knowledge industry focusing on technological research, design and development such as computer programming and biochemistry).

Labor, or the labor force, refers to the number of people employed or seeking employment.

Market, or market value, refers to the decision and pricing of goods and services guided solely by the aggregate interaction of a population and businesses. The lack of a market refers to the lack of consumer demand, or low valuation, for a product or service.

Wealth is the abundance of valuable possessions or money, or the state of being rich.

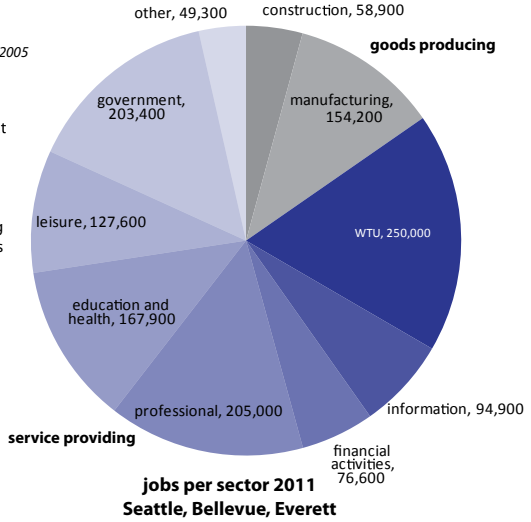


Employment

1,747,611 jobs *in Central Puget Sound, 2005*
77,255 *in Everett (4.4%)*

Regional employment during the 2000-2008 period reflects the impact of the 2001 recession. Aerospace manufacturing was among the sectors with dramatic employment declines, and subsequent job recovery. Paine Field (Manufacturing Industrial Center) lost 19% of its jobs between 2000 and 2004, and rebounded by 45.6% by 2008.

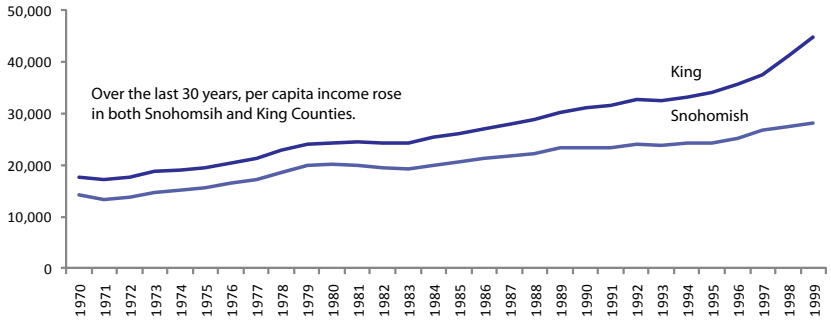
PSRC trends



jobs per sector 2011
Seattle, Bellevue, Everett

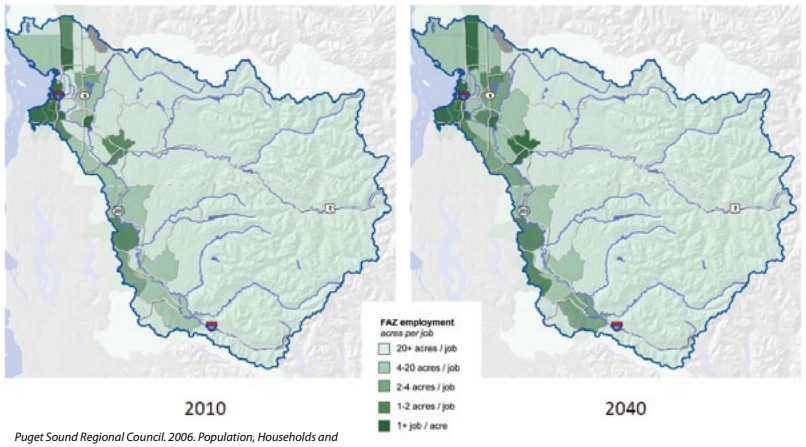
WA State Employment Security Department. March 2011. Seattle-Bellevue-Everett MD Labor Area Summary. Vol 2011. #3.

Annual per Capita Income *in '99dollars*



Puget Sound Regional Council. October 2001. Puget Sound Trends: Per Capita and Total Personal Income, 1970-1999.

Economy *published data*



Puget Sound Regional Council. 2006. Population, Households and Employment Forecasts.

PUGET SOUND AND U.S. GROWTH RATES

Average Annual Percent Change

	1970-01	2001-10
PUGET SOUND		
Employment* (thous.)	2.8	1.4
Goods producing	1.2	1.0
Construction	3.6	2.3
Manufacturing	0.4	-0.2
Service producing	3.2	1.5
Personal income (mils. $00)	4.1	3.3
Per capita income ($00)	2.4	2.2
Consumer price index (82-84=1.000)	5.0	2.7
Population, July 1	1.7	1.1
UNITED STATES		
Gross Domestic Product (bils. $00)	3.1	2.9
Employment* (mils.)	1.8	1.0
Goods producing	0.0	0.8
Construction	1.9	2.5
Manufacturing	-0.6	-0.6
Service producing	2.4	1.0
Personal income (bils. $00)	3.1	3.1
Per capita income ($00)	2.0	2.3
Consumer price index (82-84=1.000)	4.8	2.6
Population, July 1	1.1	0.8

*Wage and salary employment excluding agricultural workers and the military.

Puget Sound Regional Council. Puget Sound Economic and Demographic Forecast. February 2006.

Economy *published data*

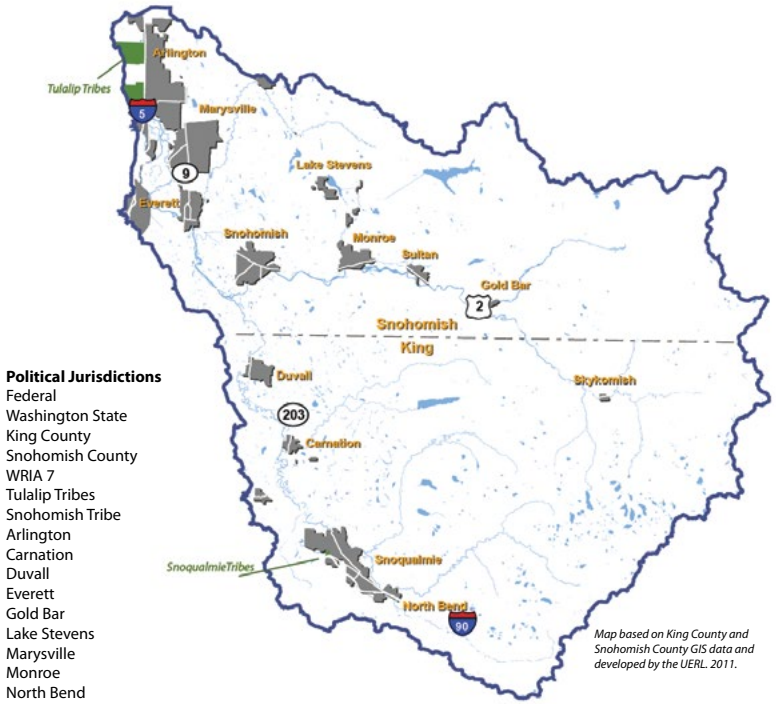
Governance

The World Bank describes governance as the rules and rulers, and the various processes by which they are selected, defined and linked together.

Politics is the process by which groups of people make collective decisions. For this project, politics refers mainly to the agencies, organization, elected officials, partnerships and jurisdictions involved in decision making.

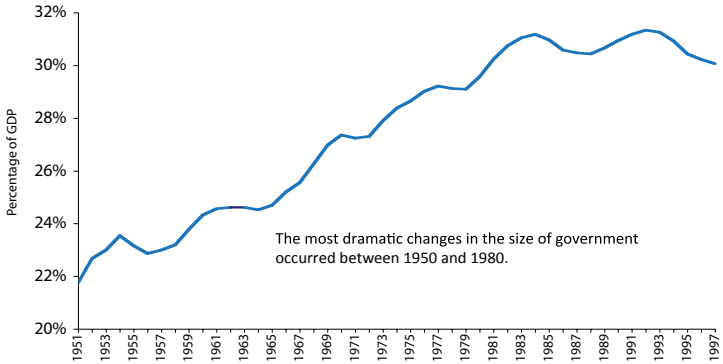
Planning and regulation refers to actions and decision carried out by government agencies towards meeting stated objectives. While regulations can compel or prohibit behaviors, planning sets out guidelines for how to achieve success by describing what the future should look like.

Services refers to those benefits that facilitate the health and safety of a population, including but not limited to social services, education, fire control, hospitals, police, parks and recreation. Provision of utilities, including waste removal, water distribution, energy and transportation is included under the heading of 'infrastructure'.

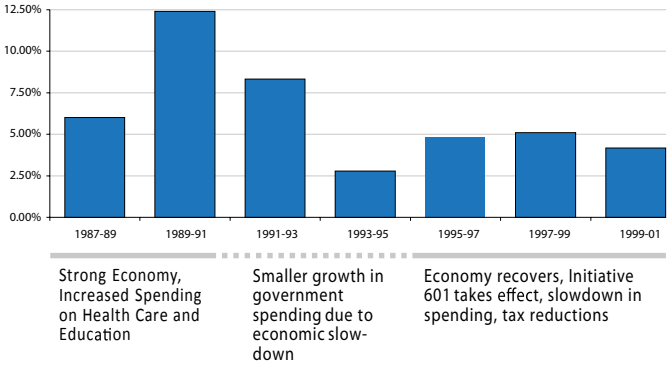


Political Jurisdictions
Federal
Washington State
King County
Snohomish County
WRIA 7
Tulalip Tribes
Snohomish Tribe
Arlington
Carnation
Duvall
Everett
Gold Bar
Lake Stevens
Marysville
Monroe
North Bend
Skykomish
Snohomsih
Snoqualmie
Sultan

Total Federal, State, and Local Government spending as a percentage of GDP, FY 1951-1997



Real Growth in State General Fund Expenditures



Office of Financial Management. August 1999. Changing the rules of the game: WA Fiscal Developments before and after initiatives 601.

Governance *published data*

Governance *published data*

Knowledge

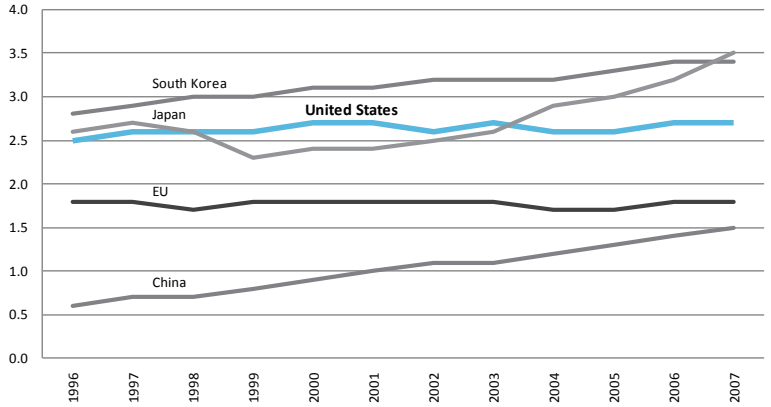
Knowledge represents the sum body of information (or facts) acquired by a population. For the purposes of this project knwledge is described in terms of the passage of knowledge through teaching or outreach, gaining new knowledge through research, science, or exploration, and innovation as the physical culmination of new ideas.

Innovation refers to the creation of new thoughts, products, processes and organization resulting from study and experimentation.

Science refers to the intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment.

Outreach is an effort by individuals in an organization or group to connect its ideas or practices to the efforts of other organizations, groups, specific audiences or the general public. Outreach often takes on an educational component (i.e., the dissemination of ideas or teaching).

R&D expenditures as share of economic output of selected countries: 1996-2007



National Science Board. January 2010. Science and Engineering Indicators: 2010. R&D expenditures as share of economic output of selected countries: 1996–2007.

Research and Development Funds

Washington Innovation Statistics
4.85% of Washington's GDP is in Research and Development ($15,061mil) ranking the State in fourth place nationally.

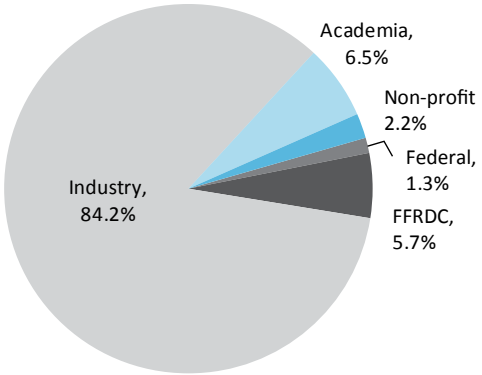
The far majority of that money stems from industry.

53 Patents per 100,000 people (210% of US)

$195 NSF funding to Universities (per capita, 2005; 300.6% of US)

$300 Venture capital funding (per capita, 2006; 341.4% of US)

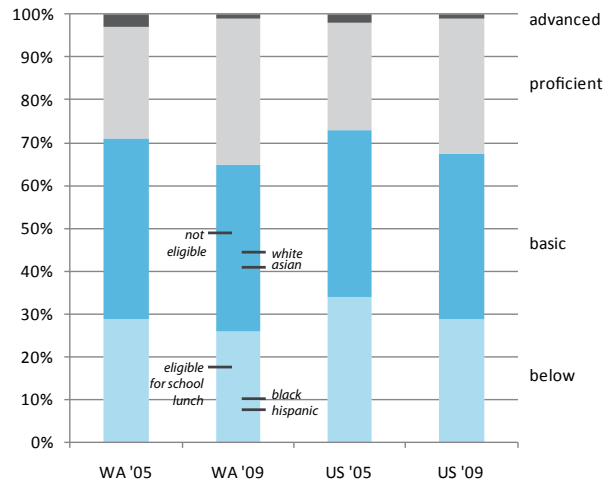
6.7 Research and Development workers per 1,000 workers (163.6% of US)



Brookings Institute. 2005. MetroNation Profile: Puget Sound Region.

Knowledge *published data*

4th Grade Science Proficiency



Science Statistics - Washington State

In 2009, the average score of fourth-grade students in Washington was 151. This was not significantly different from the average score of 149 for public school students in the nation.
In 2009, Black students had an average score that was 34 points lower than White students. Hispanic students had an average score that was 35 points lower than White students. Students who were eligible for free/reduced-price school lunch, an indicator of low family income, had an average score that was 29 points lower than students who were not eligible for free/reduced-price school lunch. While these performance gaps are not significantly different from the nation, they do indicate prioritized social reform challenges.

Higher Education Attainment

35.8% of adults with bachelors degree (131.8% of US)

12.3 with graduate degree (123% of US)

52.2% recent in-movers with bachelor's degrees (138% of US)

Brookings Institute. 2005. MetroNation Profile: Puget Sound Region.

Knowledge *published data*

Social Institutions

In addition to economy, governance and knowledge, social institutions represent groups that share some mental concept of right and wrong, order and relationships, and patterns of good (positive values). Institutions, by definition, are resistant to change and are there to support the current status.

Community, in this context, refers to a social group with shared resources or beliefs.

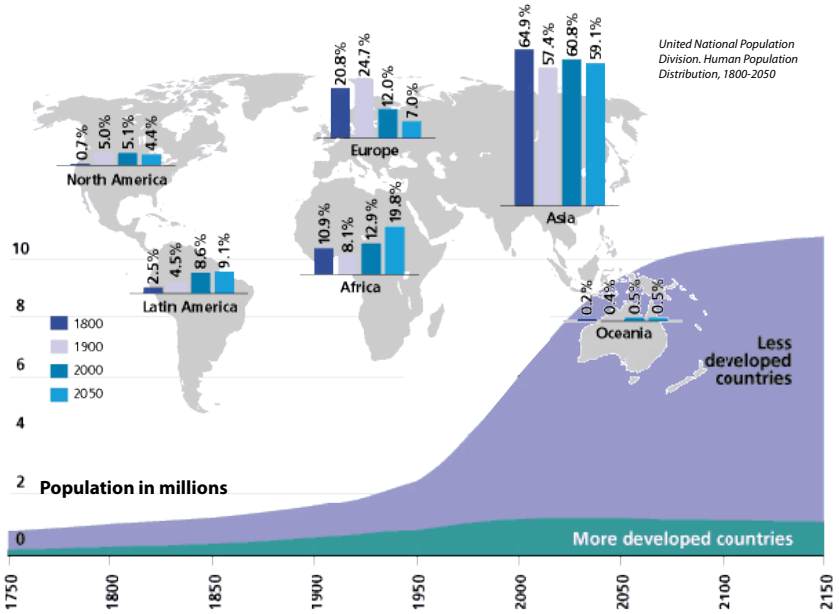
The term **culture**, in this context, refers to the anthropologically distinct ways that different people living in different physical or socio-economic areas represent and share their experiences. Further, culture refers to those arts and humanities associated with 'good taste'.

Organizations are a social arrangement to distribute tasks for a collective goal. In this context, organizations refers to non-governmental organizations, international organizations, charities, not-for-profit corporations, partnerships, cooperatives, and universities. In general, organization can also refer to governmental and for-profit organizations; these can be found under 'politics' and 'industry' respectively.

Native American tribes refer to any extant or historical tribe, band, nation, or other group or community of Indigenous peoples in the United States. **Tribes** are often associated with territory in the form of a reservation. The Snohomish Basin is home to both the Tulalip Tribes and Snoqualmie Tribes.

The **world** refers to international affairs, other countries, and global changes.

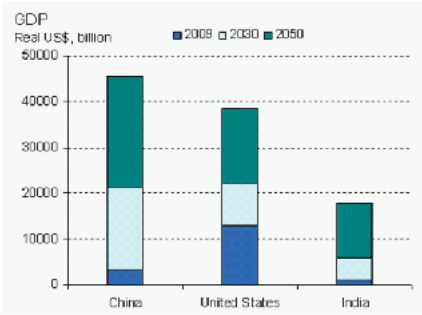
Public engagement, or political will, entails the combination of three factors: opinion, intensity and saliency. Opinions are shaped by awareness of topics and sway of issue formation. Intensity is shaped by how much we care about something. Lastly, saliency, the connection to public affairs, the relevance to mass population is necessary.



United National Population Division. Human Population Distribution, 1800-2050

United Nations Population Reference Bureau. World Population Growth, 1750-2150.

China, India, and the United States will emerge as the world's three largest economies in 2050. Their total GDP, in real U.S. dollar terms, will be over 70 percent more than that of the other G20 countries combined. In China and India alone, GDP is predicted to increase by nearly $60 trillion—the current world GDP—but the wide disparity in per capita GDP among these three will persist.



Dadush, U. and B. Stancil. 11.19.2009. The G20 in 2050. International Economic Bulletin: Weekly economic commentary and analysis from the Global Think Tank.

Social Institutions *published data*

Chronology of Tulalip History

1792	Snohomish tribes meet explorer Captain George Vancouver.
1820	Fur trade routes established though Puget Sound region.
1833	Possible date of Camano Head falling and burying a Snohomish village below it, causing a large number of deaths.
1841	Captain Charles Wilkes is the first American to chart the waters of Puget Sound.
1842	Settlers start to move into the Puget Sound region.
1848	The Oregon Territory is created with the provision that Indian lands and property cannot be taken without Indian consent.
1853	The Washington Territory is created with the provision that the US has the right to regulate Indian land, property and other rights.
1853	Several Americans build a sawmill and homesteads on Tulalip Bay.
1855	On January 22nd, Governor Isaac Stevens concludes the Treaty of Point Elliott at Mukilteo, which establishes the Tulalip Reservation.
1859	Treaty ratified by U.S. Congress, and soon, the Tribes that agreed to the treaty begin to settle in the vicinity of Tulalip Bay.
1861	Snohomish County is created.
1863	Father Chirouse opens a new school on the Tulalip Reservation.
1868	Sisters of Charity of Montreal begin the education of Indian girls on the Tulalip Reservation.
1869	Father Chirouse receives a contract with U.S. Government to support the Tulalip Mission School of St. Anne.
1875	Congress extends the homestead laws to Indians willing to abandon their tribal affiliation.
1875	Canning process improves and a large commercial fishery begins to develop.
1883	John Slocum founds the Indian Shaker Church near Olympia, a form of religion that some Tulalip people will join.
1884	Allotment of Tulalip Reservation begins.
1887	Congress passes the General Allotment Act, which allots land on reservations to individual Indians.
1889	Washington becomes a state.
1891	Seattle and Montana Railway is completed, this rail service is the first in the vicinity of the Tulalip Reservation.
1902	A new school is built on Tulalip Reservation, called the Tulalip Indian Boarding School.
1915	A Tulalip Indian is jailed for hunting on contested reservation land.
1912	First Tulalip Treaty Days celebration is held through the efforts of William Shelton to preserve the songs and dances.
1916	Destruction of fish habitat begins through logging, dredging, agriculture, industry and the creation of dams and developments.
1924	Indian Citizenship Act passed by Congress. Indians become citizens and can now vote.
1924	Steelhead becomes a game fish.
1928	The Problem of Indian Administration is presented and is highly critical of U.S. Indian policy
1930	Beginning of fish ladders being installed on dams.
1933	Steelhead becomes a sport fish.
1934	Indian Reorganization Act is passed by Congress, enabling tribes to organize in local self government and elect leaders.
1935	Indians of the Tulalip Reservation write a constitution and vote to approve it.
1936	The secretary of the Interior approves the Tulalip Constitution, and Tulalips elect their first Board of Directors.
1939	Tulalips begin to lease land for homes on Tulalip Bay.
1946	Congress creates Indian Claims Commission to settle disputes between Indians and the Federal Government.
1950	Tulalip Agency of the BIA is moved from Tulalip Reservation and the new Western Agency is located in Everett, Washington.
1973	Washington Department of Game gives Indians the right to fish steelhead.
1974	The Boldt decision gives Washington Indian Tribes the right to co-manage fishing resources and take 50% of the harvestable fish.
1975	The Indian Self-Determination and Education Assistance Act is passed
1978	The American Indian Religious Freedom Act passed, which protects the traditional religious practices of Native Americans.
1979	U.S. Supreme Court upholds the 1974 decision of U.S. v. Washington (the Boldt decision).
1979	Tulalip revives the First Salmon Ceremony, which continues to be held annually.
1985	Pacific Salmon Treaty signed between the United States and Canada.
1985	Puget Sound Salmon Management Plan adopted by the Washington Department of Fisheries and the Indian Tribes.
1985	Puget Sound Water Quality Authority is created by Gov. Booth Gardner, with Tribal representatives being appointed to it.
1990	Native American Graves Protection and Repatriation Act passed by U.S. Congress.

Tulalip Tribes Website

Social Institutions *published data*

Development

Development describes the settlement pattern on the landscape and changes in land use and in land cover.

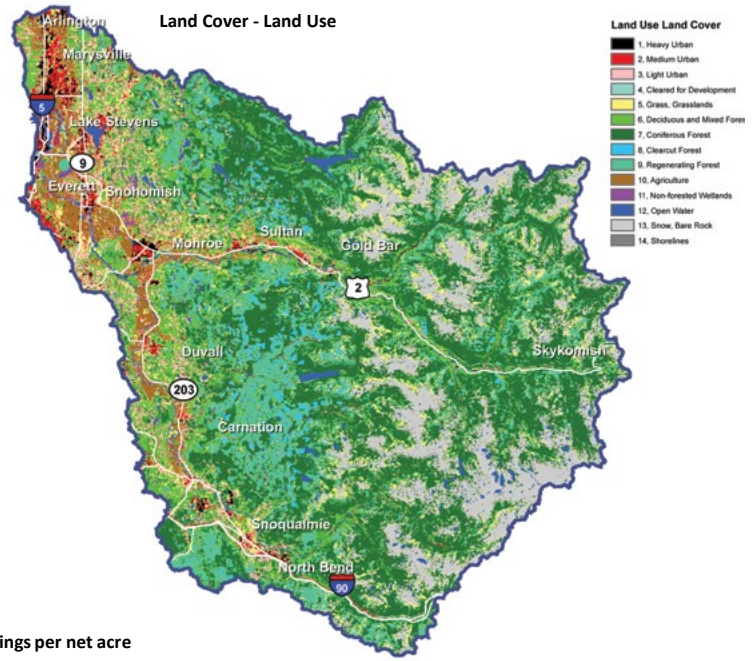
Character describes the actual look and feel of the development or landscape, whether rural or urban, resource-based or hobby ranchette, green build-low impact construction or dominated by impervious surfaces.

Form indicates the shape and pattern of development.

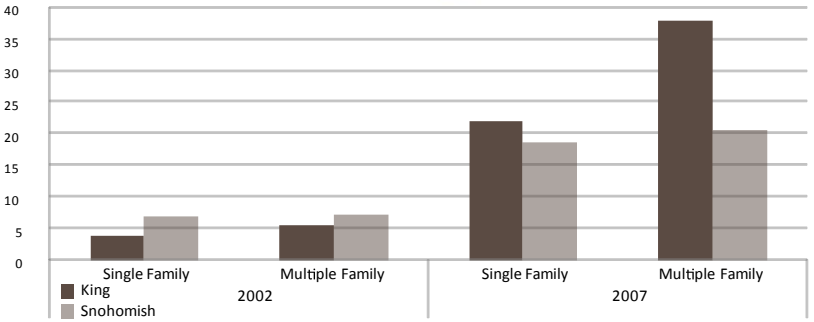
Land use refers to the management and modification of natural environment into the built environment for human use. Land use is generally categorized as residential, industrial, commercial, open space and agriculture.

A municipality refers to a town or city with a defined local government authority, territory and associated population.

Real estate refers to the value (cost) associated with a property of land along with improvements such as buildings.

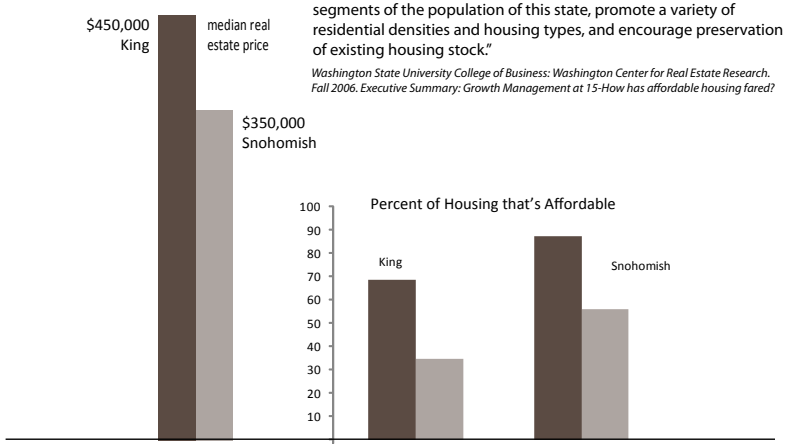


Dwellings per net acre



Buildable Lands Report 2002, 2007

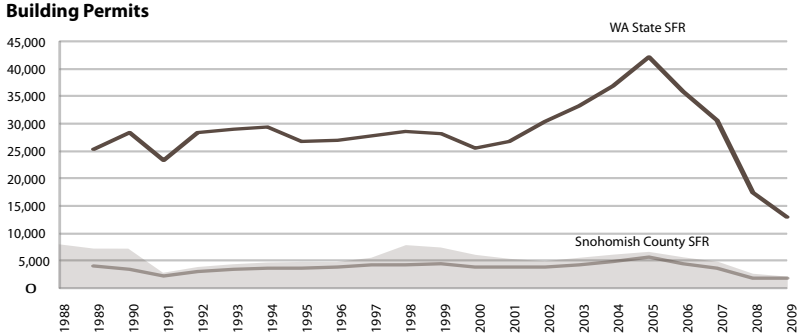
Development *published data*



"Encourage the availability of affordable housing to all economic segments of the population of this state, promote a variety of residential densities and housing types, and encourage preservation of existing housing stock."

Washington State University College of Business: Washington Center for Real Estate Research. Fall 2006. Executive Summary: Growth Management at 15-How has affordable housing fared?

Building Permits



Washington State University College of Business: Washington Center for Real Estate Research. Washington State Single Family Building Permits (Annually) 1988-2009

Development *published data*

Infrastructure

The term typically refers to the technical structures that support a society, such as roads, water supply, sewers, electrical grids, telecommunications lines, and so forth.

Energy provision refers to the effort to provide sufficient energy sources for a population to operate transportation, heating and cooling, appliances and machinery. Energy consumption refers to the usage of energy by a population associated with needs and behavior. Energy production refers to the transformation, storage and transmission of energy from fossil fuels, nuclear material, biomass, wind, solar, tidal, and water (dams) to usable forms.

Flood mitigation refers to dams, dikes, levees and armaments. These systems influence the timing and flow of the waterway in order to decrease upland flooding by hardening of the shoreline and / or the raising of the stream bank to reduce flood events.

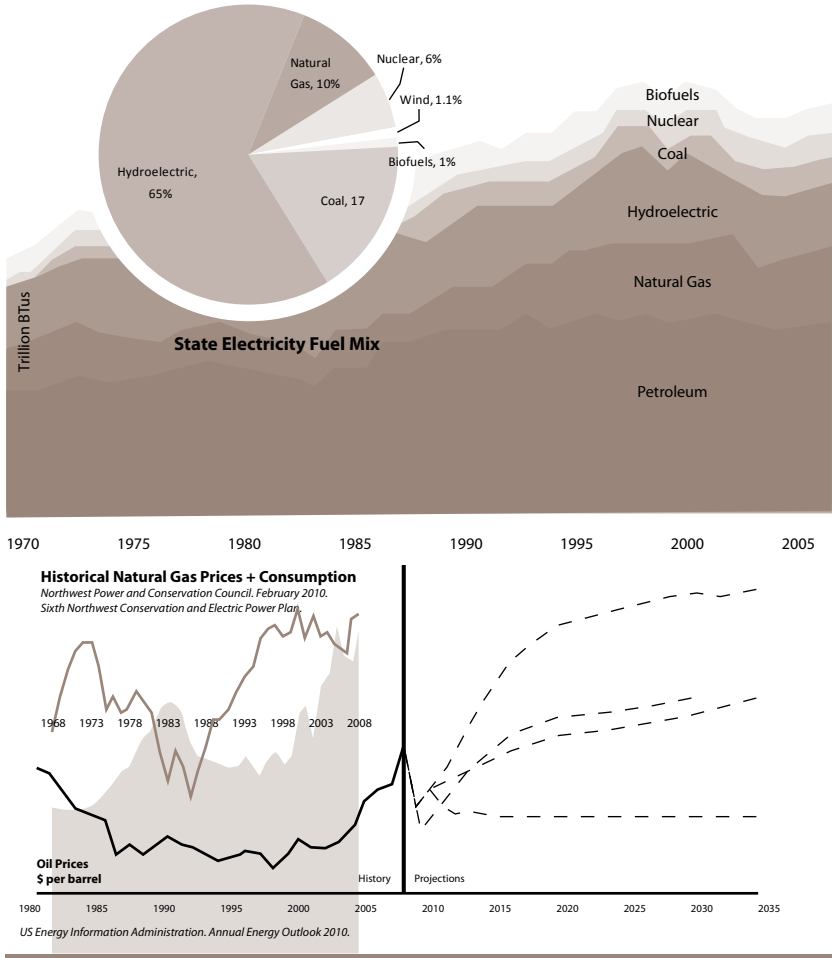
Transportation is the movement of people and goods across a landscape. Transportation entails the infrastructure network, modes of travel, and associated environmental, social and economic costs.

The waste stream describes the overall disposal cycle for a population including air and water pollution, solid waste and recycling, as well as sewer and septic infrastructure.

Water provision refers to the supply of clean drinking water to a population by a public utility or individual wells. Water provision includes the management, storage and distribution of water resources.

National Total Primary Energy Consumption by Source

Washington State Department of Community, Trade & Economic Development. Washington End-Use Energy Consumption by Sector.

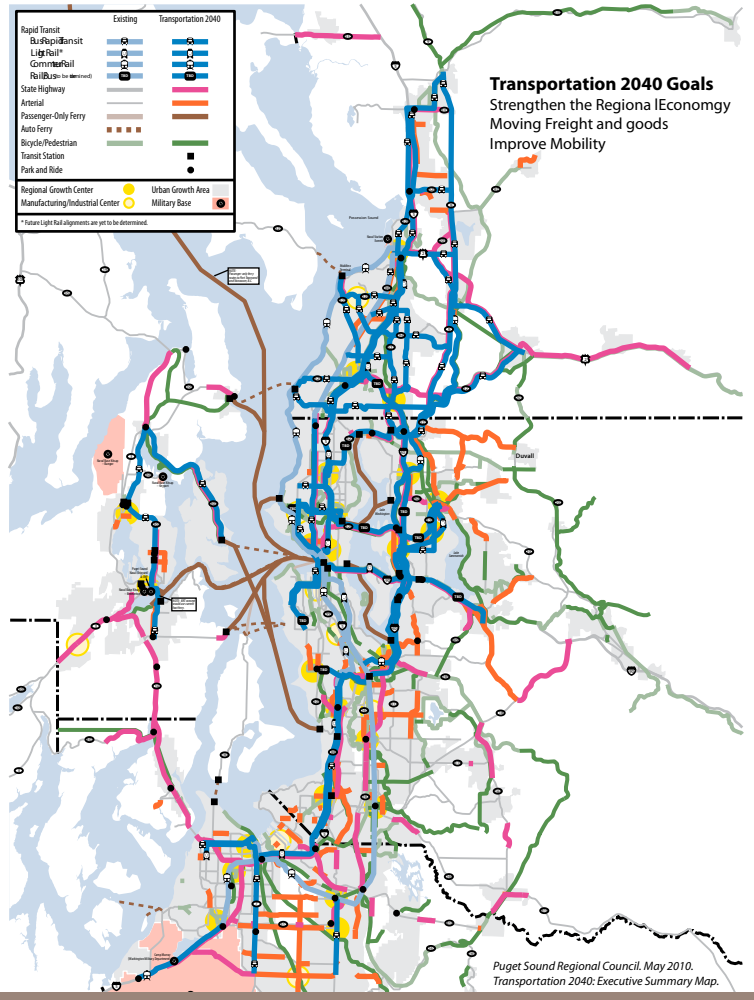


Historical Natural Gas Prices + Consumption

Northwest Power and Conservation Council. February 2010. Sixth Northwest Conservation and Electric Power Plan.

US Energy Information Administration. Annual Energy Outlook 2010.

Infrastructure *published data*



Puget Sound Regional Council. May 2010. Transportation 2040: Executive Summary Map.

Infrastructure *published data*

Resource Management

Materials or substances such as minerals, forests, water, and fertile land that occur in nature and can be used for economic gain.

Agriculture refers to the activity or business of growing crops and raising livestock.

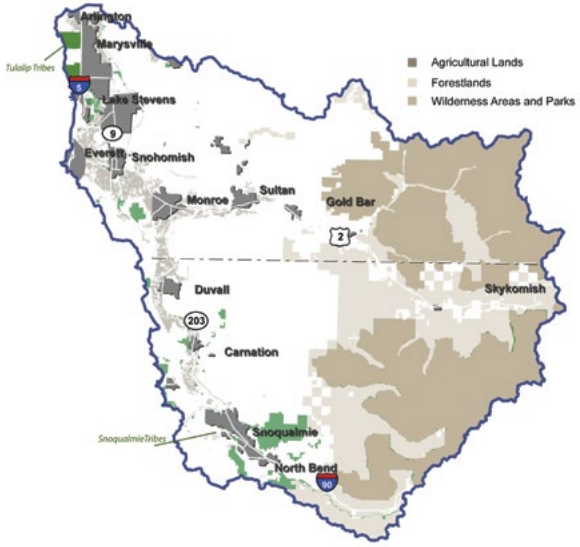
Forestry is the science of planting and caring for forests and the management of growing timber. and other valued forest products.

Recreation refers to the expenditure of time in a manner designed for therapeutic refreshment of one's body or mind.

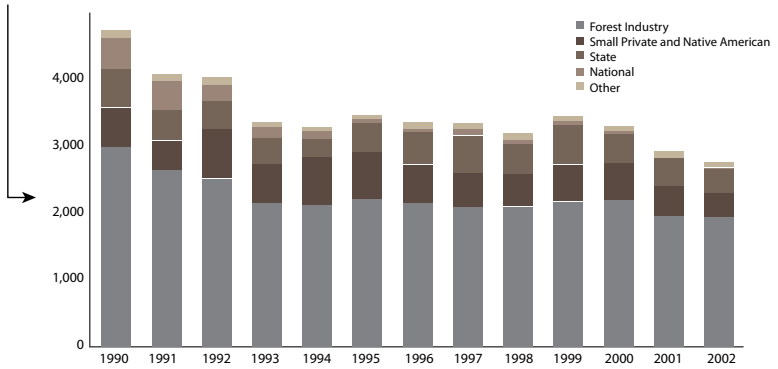
Forestland at Risk

There are 361,187 acres of private forestland in WRIA 7. Of those, 185,959 are DFL protect while 151,709 (87%) are at high risk of development.

Department of Revenue Washington State. 2011. Harvest Statistics.



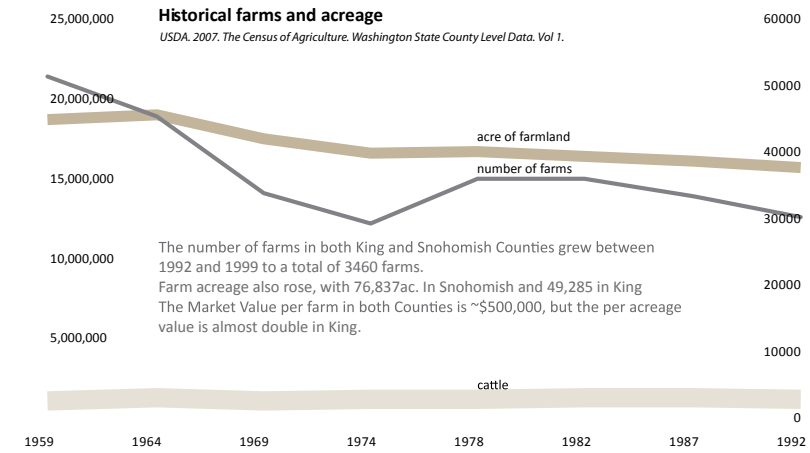
There are 410,344 acres of forestland in King County and 319,300 acres in Snohomsish. In King the majority is in industrial (41%) while in Snohomish the majority is in small private ownership (68%)

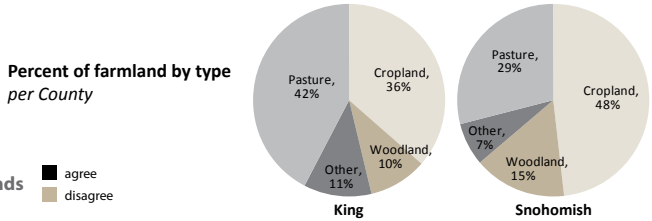


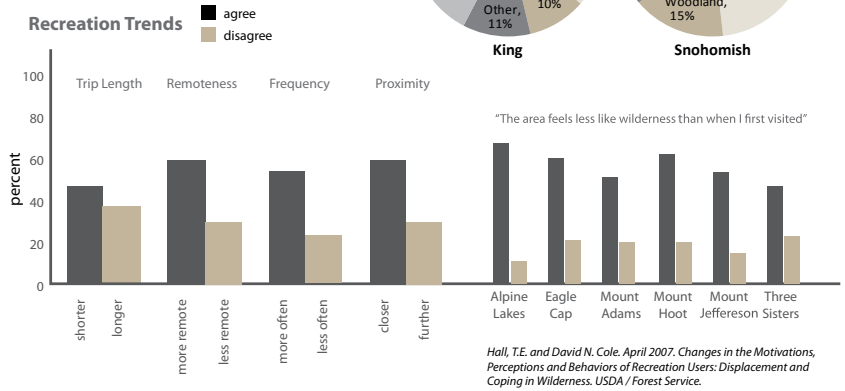
Acres of Forestlands in Washington

College of Forest Resources: University of Washington. March 25, 2001. Retention of High Valued Forest Lands at Risk of Conversion to Non-Forest Uses in Washington State.

Resource Management *published data*







Hall, T.E. and David N. Cole. April 2007. Changes in the Motivations, Perceptions and Behaviors of Recreation Users: Displacement and Coping in Wilderness. USDA / Forest Service.

Resource Management *published data*

Biophysical Template

Biophysical template focuses on the partitioning and cycling of chemical elements and compounds between the living and nonliving parts of an ecosystem.

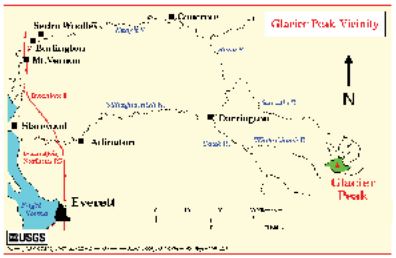
Nutrients, such as nitrogen and phosphorus, stem from emisisons, sewers and fertilizers to enhance plant growth. **Toxic chemicals**, such as lead, mercury, sulfur are associated with industrial pollution, pesticides and vehicle leaks. When concentrations are too high, nutrients and toxic chemicals can damage and even kill organisms.

Landscape movement refers to the migration of soil (earth, dirt) both through water (bedload transport and sedimentation), over land (erosion) and through wind (lahars) and through snow (avalanches).

Seismology is the study of earthquakes propagated through waves in the earth's crust. The field also includes studies of tsunamis and volcanic eruptions

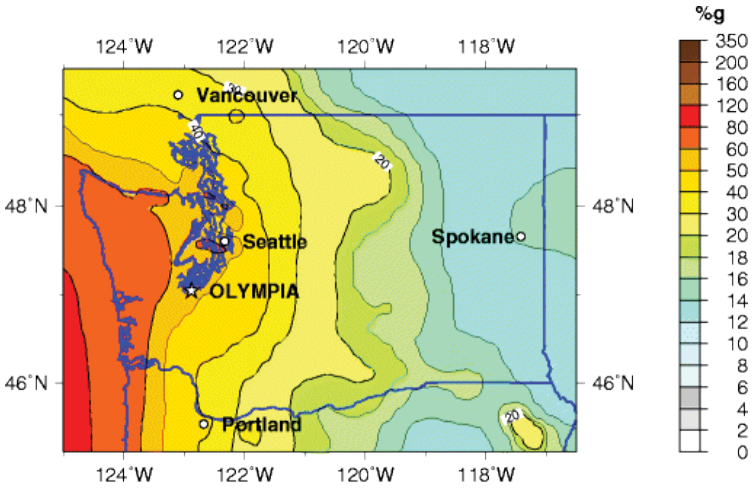
Soil is the unconsolidated mineral or organic material on the immediate surface of the Earth that serves as a natural medium for the growth of land plants. Soil productivity is the output of productive capability to support organic materials over a specified area. Soil minerals, such as gravel, gold, copper and silver may be extracted (mined) for economic profit.

Glacier Peak - Volcanic Activity *USGS. Glacier Peak: History and Hazards of a Cascade Volcano*



Glacier Peak lies only 70 miles northeast of Seattle -- closer to that city than any volcano except Mount Rainier. But unlike Mount Rainier, it rises only a few thousand feet above neighboring peaks, and from coastal communities it appears merely as a high point along a snowy saw-toothed skyline. Yet Glacier Peak has been one of the most active and explosive of Washington's volcanoes. -- *Excerpt from: Mastin and Waitt, 2000*

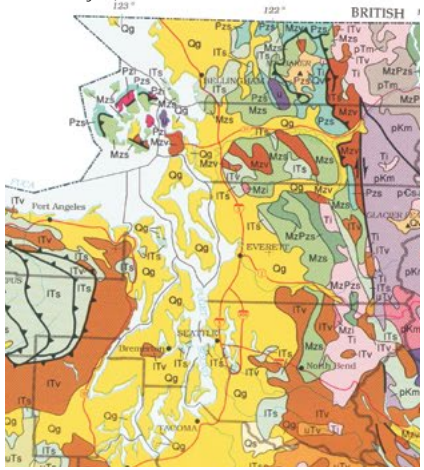
USGS Seismic Hazard Map *USGS. Seismic Hazard Map. http://earthquake.usgs.gov/earthquakes/states/washington/hazards.php*



Peak Acceleration (%g) with 2% Probability of Exceedance in 50 Years
site: NEHRP B-C boundary
National Seismic Hazard Mapping Project (2008)

Biophysical template *published data*

USGS. Geologic Map of the North Cascade Range, Washington. 10.15.10. Haugerud, R.A. and R.W. Tabor



Geologic Map of Northern Cascades

The Cascade Range is part of a vast mountain chain that extends from British Columbia to northern California. It separates the coastal Pacific lands from the interior of North America. The Cascades consist of an active volcanic arc superimposed upon bedrock of Paleozoic to Tertiary age. Pliocene to recent uplift has created high topographic relief. As a result, the Cascades form an effective barrier to moisture carried eastward by the prevailing Pacific winds. This has a great effect on the productivity of the land.

Qg Quaternary sediments, dominantly glacier drift; includes alluvium

Sedimentary Rocks

- uTs Upper Tertiary (Pliocene–Miocene)
- lTs Lower Tertiary (Oligocene–Paleocene
- Mzs Mesozoic
- MzPzs Mesozoic–Paleozoic
- Pzs Paleozoic
- pCs Precambrian

An avalanche occurs when a layer of snow loses its grip on a slope and slides downhill. When the snow piles up and conditions are right, avalanches result. Avalanches have killed more than 190 people in the past century in Washington State, exceeding deaths from any other natural hazard.

WA Military Department. Emergency Management Division. Natural Hazards: Avalanches.

Biophysical template *published data*

Climate

Climate is how the atmosphere "behaves" over relatively long periods of time. Climate change refers to long-term shifts in the statistics of weather. Climate change incorporates both natural variability and human-induced change.

Air quality is defined as a measure of the condition of air relative to the requirements of one or more biotic species and / or to any human need or purpose.

Carbon dioxide, a side product of fossil fuel combustion, is a greenhouse gas associated with environmental pollution and climate impacts.

Confounding anthropogenic changes to climate patterns are **natural variations** associated with La Nino, El Nino and Pacific Decadal Oscillation, jet stream shifts as well as solar radiance. These variations may create large variations in wind, temperature and precipitation patterns.

Climate change will influence different areas of the world in various magnitudes and pathways. **Global change** refers to climate impacts that are relevant on a global scale, as opposed to changes significant within the Basin or Region.

Ocean acidification is the name given to the ongoing decrease in the pH of the Earth's oceans, caused by their uptake of excess carbon dioxide from the atmosphere.

Precipitation is the product of the condensation of atmospheric water vapor that falls under gravity in the form of rain or snow.

Sea level measures of the average height of the ocean's surface, halfway between the mean high tide and the mean low tide. Sea level has been increasing over the last century due to human-induced climate change through three main processes: thermal expansion, the melting of glaciers and ice caps, and the loss of ice from the Greenland and West Antarctic ice sheets.

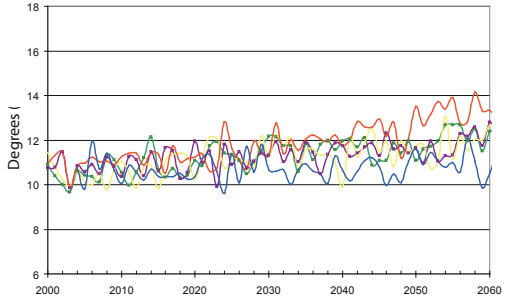
Snowpack forms from layers of snow that accumulate in geographic regions and high altitudes where the climate includes cold weather for extended periods during the year. Snowpack is an important water resource that feedsstreams and rivers as they melt. Snowpack is the drinking water source for many communities.

Temperature shift, or warming, refers specifically to changes in ground-level atmospheric temperature.

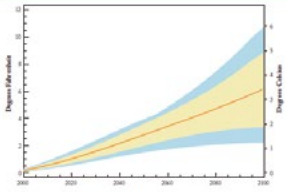
21st Century Climate Impacts for the Pacific Northwest Region

University of Washington and NOAA. Dec 6, 2005. Modeling the Impacts of Climate Change and Restoration on Chinook Salmon in the Snohomish Basin.

Annual Average Temperature *at Snoqualmie Falls*

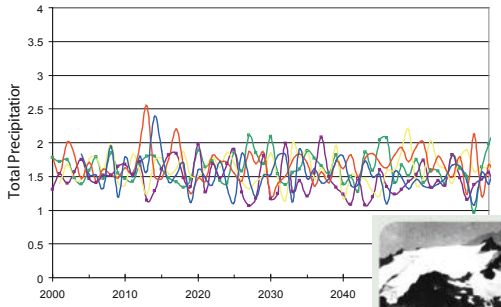


Warming since 1900 in the Pacific Northwest ranges from 0F to 4F. By 2100, models project warming near 5F west of the Cascades, with much larger warming further east in the Canadian model.



Northwest Warming Trends

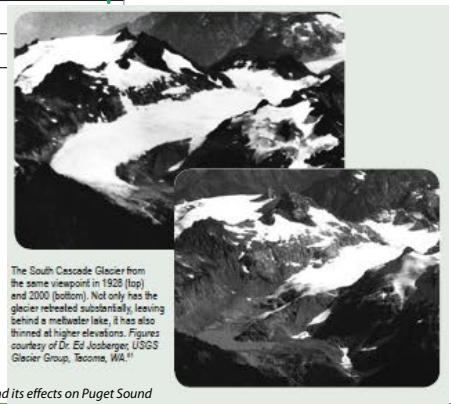
Annual Precipitation *at Snoqualmie Falls*



Precipitation has increased over most of the Pacific Northwest since 1900. Climate models project continued precipitation increases, with the largest increases in the southern part of the region.

Snowpack

Nearly every glacier in the Cascades and Olympics has retreated during the past 50-150 years in response to warming.21 Small glaciers are disappearing rapidly, and glacial mass is being reduced on the larger ones. While the total water input into Puget Sound from melting glaciers is minimal, glacial retreat can have important local effects. In higher reaches of certain river basins (such as the Nooksack) and some tributaries to the Skagit, melting glaciers provide a substantial portion of stream flow in late summer. This is also true for the Nisqually River, which is fed by receeding glaciers on Mt. Rainer. Glaciers also have significant local effects on stream temperature and water supply for aquatic plants and animals. Significant reductions in glacial input to streams would dramatically alter vulnerable aquatic habitat.

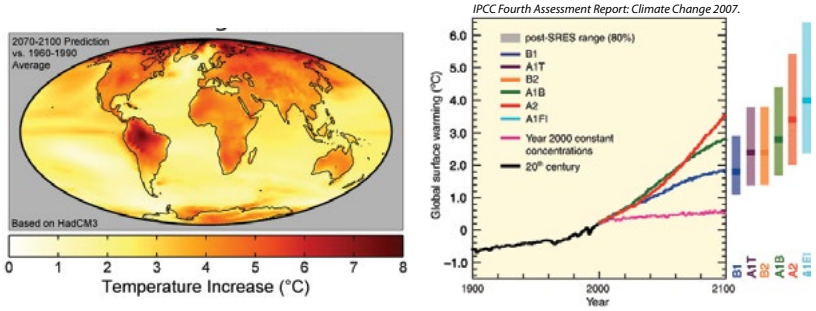


The South Cascade Glacier from the same viewpoint in 1928 (top) and 2000 (bottom). Not only has the glacier retreated substantially, leaving behind a meltwater lake, it has also thinned at higher elevations. Figures courtesy of Dr. Ed Josberger, USGS Glacier Group, Tacoma, WA.[1]

Climate Impacts Group. Oct 18.2005.Uncertain Future: Change and its effects on Puget Sound

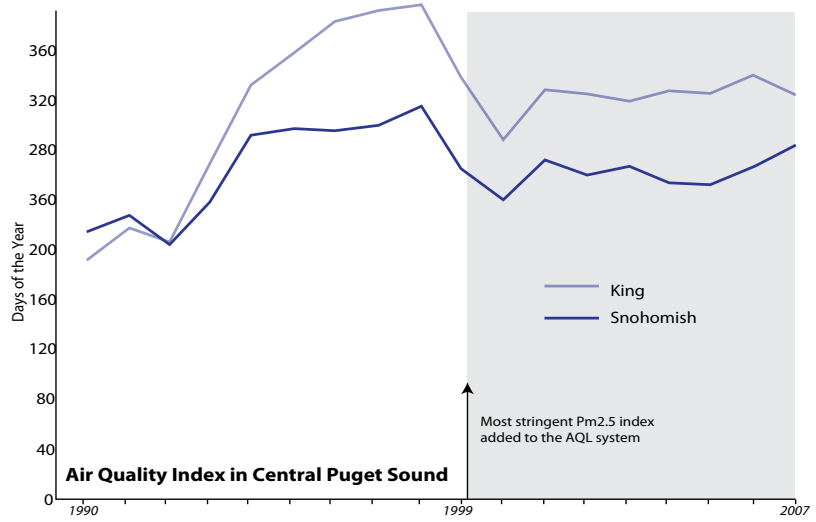
Climate *published data*

Global Climate Impacts



Eleven of the last twelve years (1995-2006) rank among the twelve warmest years in the instrumental record of global surface temperature (since 1850). The 100-year linear trend (1906-2005) of 0.74 [0.56 to 0.92]°C[1] is larger than the corresponding trend of 0.6 [0.4 to 0.8]°C (1901-2000).

NASA. Annual average global warming by the year 2060 simulated and plotted using EdGCM.



Puget Sound Clean Air Agency; PSRC

Climate *published data*

Hydrology

Hydrology is the study of water, including the movement, distribution and quality of water (or water bodies).

A **flood** is an overflow of an expanse of water that submerges land.

Groundwater is water located beneath the ground surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water.

Morphology refers to the shape of the river, how straight it is, its width and the presence of eddies.

Stormwater refers to overland flow due to precipitation and snowmelt that is not intercepted or infiltrated.

The **'watershed'** refers to the Snohomish Basin, its three major watersheds, (Snohomish, Skykomish and Snoqualmie), and its four major rivers, (Snohomish, Skykomish, Snoqualmie and Tolt).

Water quality is a measurement of physical, chemical and biological characteristics of water. Water quality matters for clean drinking water and public health, salmon protection (fish and habitat) and recreation.

Water quantity refers to water available for human consumption, industrial use and in-stream habitat.

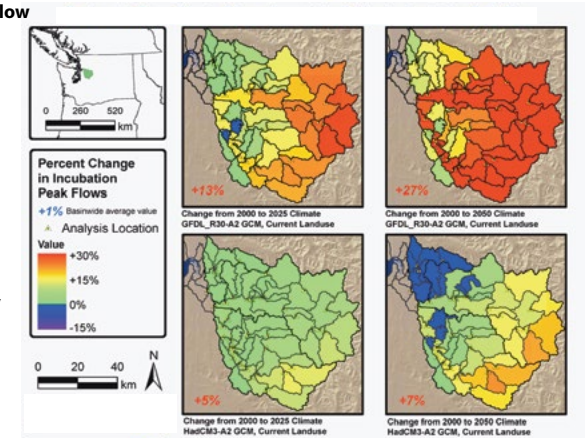
WRIA 7

Water Resource Inventory Area 7 includes the 4 major river basins of the Snohomish, Snoqualmie, Skykomish and Tolt. This Basin is known for both its once abundance salmon tributaries and frequently flooding rivers.

Hydrologic Impacts- Peak Flow

The GFDL model forecasts more significant increases in the peak flows with higher winter temperature increases and increased winter precipitation.

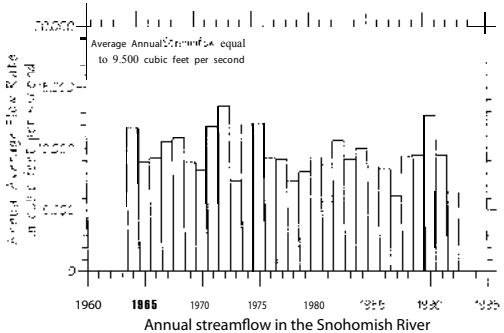
The upland basins are in a transitional state where precipitation may fall as rain or snow. Temperature shifts will change the state of the precipitation and can noticeably shift the hydrologic response of the basin. The lower basins mainly just receive rain and so the temperature warming will not create the same impacts.



Hydrology *published data*

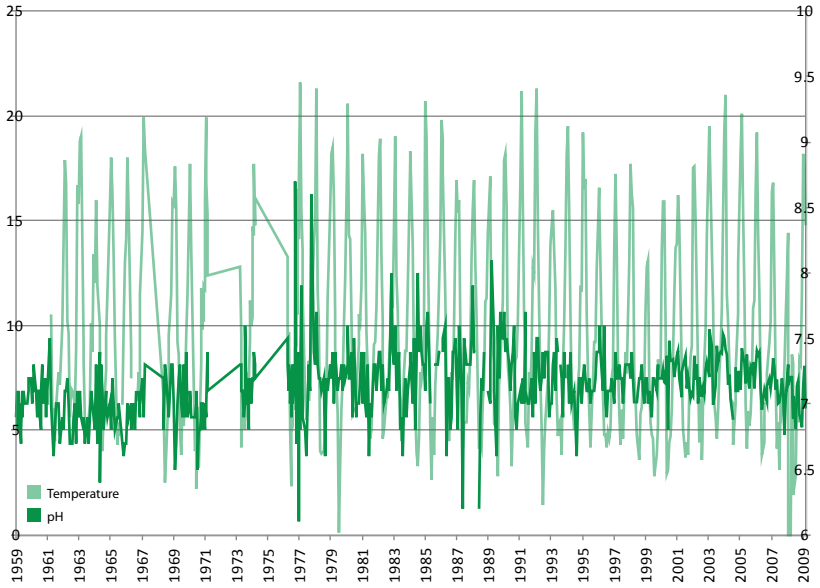
Streamflow

Annual streamflow in the watershed varies widely from one year to the next in a pattern which reflects annual precipitation. This high variability is demonstrated by the annual flow record on the Snohomish River at Monroe. Long-term trends in annual streamflow will be affected by trends in precipitation, water consumption and land use practices. Recent analysis of annual streamflow trends, adjusted for precipitation, is inconclusive but suggests a possible reduction in streamflow over time.



Annual streamflow in the Snohomish River

Water Quality at Snohomish River Station *Ave D in Snohomish*



Hydrology *published data*

Terrestrial Biosphere

The terrestrial biosphere is a thin layer around the earth's crust that supports life. The terrestrial biopsphere works in concert with the lithosphere, hydrosphere and atmosphere. The terrestrial biosphere encapsulates organisms and their habitat.

Biodiversity reflects the full complement of species and ecosystems within an area requiring intact ecological functions and processes.

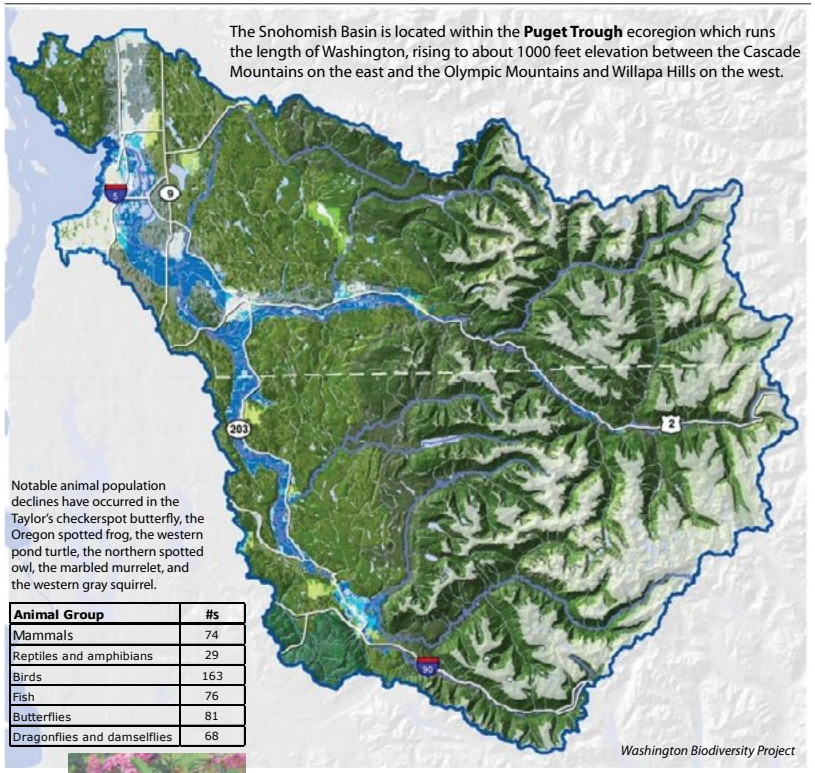
Estuaries are the transition zone between the ocean and rivers. Estuaries are subject to both marine influences, such as tides, waves, and the influx of saline water and riverine influences, such as flows of fresh water and sediments.

Wildland fires are fires caused by nature or humans that result in the uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property. Urban or industrial fires, caused by technological hazards were not discussed by participants.

Forest habitat consists of lowland riparian forests and upland conifer forests dominating the land cover in the Basin.

Invasive species applies to non-indigenous species, or "non-native", plants or animals that adversely affect the habitats and bioregions they invade economically and environmentally.

Salmon, more specifically the Pacific Salmon of the family Salmonidae, generally refer to anadromous fish that migrate from upland stream tributaries to the ocean, and then back upstream to spawn. Pacific salmon are the Northwest's biological and cultural icon. Salmon, and their associated habitat, is protected by the Endangered Species Act.



The Snohomish Basin is located within the **Puget Trough** ecoregion which runs the length of Washington, rising to about 1000 feet elevation between the Cascade Mountains on the east and the Olympic Mountains and Willapa Hills on the west.

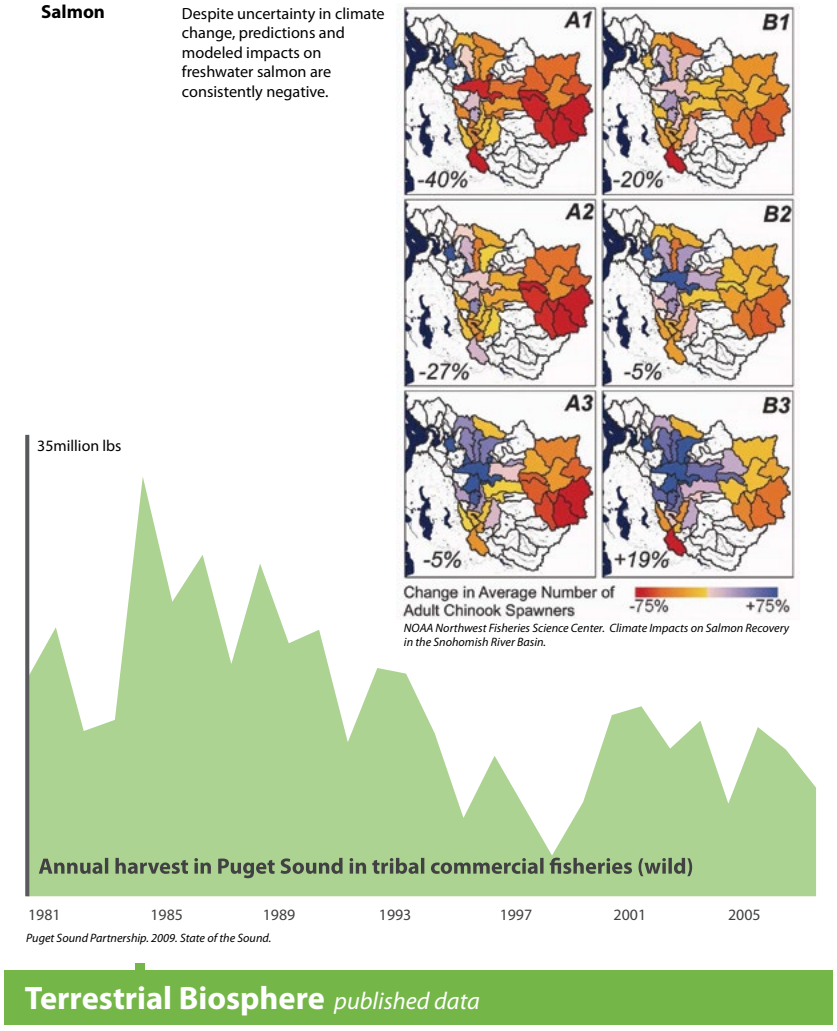
Washington Biodiversity Project

Notable animal population declines have occurred in the Taylor's checkerspot butterfly, the Oregon spotted frog, the western pond turtle, the northern spotted owl, the marbled murrelet, and the western gray squirrel.

Animal Group	#s
Mammals	74
Reptiles and amphibians	29
Birds	163
Fish	76
Butterflies	81
Dragonflies and damselflies	68

The butterfly bush is one of 153 non-native plants and 30 noxious weeds found in the Basin.

Historically, coniferous forest dominated the vegetation in the Puget Trough ecoregion. Many of the planet's most impressive stands of trees grew here. Also present were a mix of riparian habitats, oak woodlands, and prairies. The vegetation in most of the ecoregion's landscapes has now been altered. Cities, suburbs, and industrial lands are common. Managed forests and agricultural lands changed the vegetation, and themselves face pressure from sprawling development. The native forest here is primarily of Douglas fir, western red cedar, and western hemlock. Red alder and big leaf maple grow in riparian areas. Red alder also colonizes areas disturbed by fire or logging. Understory plants include sword fern and shrubs such as snowberry, Oregon grape, salmonberry, and many others.



Assessment of Relationships between Drivers

The conceptual model workshop highlighted the differences and similarities in how experts organize the relationship between drivers, in terms of both their impacts and feedbacks. What came across as an essential piece is the need to synthesize the various relationships in a systematic manner (as opposed to simplifying only the most commonly shared concepts).

We coded interview transcripts based on the initial list of drivers to assess member comments about the relationships between drivers. For example, if a member said 'population growth is dependent on more jobs' we tallied 1 comment for economy>labor impacting demographics>growth. Based on the tallies of all 44 interviews and focus groups we created a cross-interaction matrices and series of network graphs to illustrate the cumulative set of comments describing the relevance of various relationships.

The series of network graphs (pages A6.64-70) isolate the represented relationships per driver. Drivers are organized from top to bottom based on whether they drive (top) or are driven by (bottom) the specified driver. The number of comments tallied are provided by each arrow head.

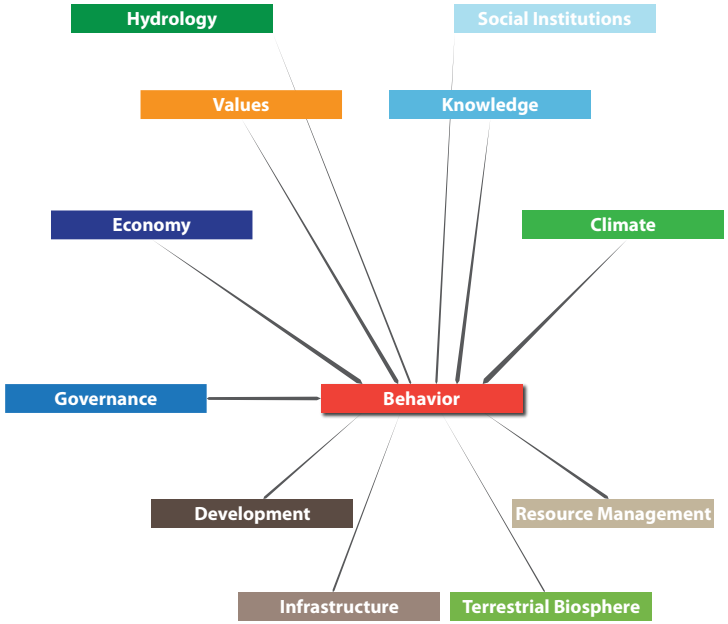
The cross interaction matrices summarizes the relationships in a tabular format where the list of drivers is repeated along the top row and left hand side. Cell values represent the number of times a comment was made on on the interaction between two drivers (page A6.71-73).

Science Team member descriptions of each driving forces' relevance, importance and uncertainty during focus group meetings are included in pages A6.74-87.

according to our Science Team

Behavior

is most directly influenced by economy , climate, values and knowledge
is responsible for driving the built environment and alterations to the terrestrial biosphere



relationship not described*

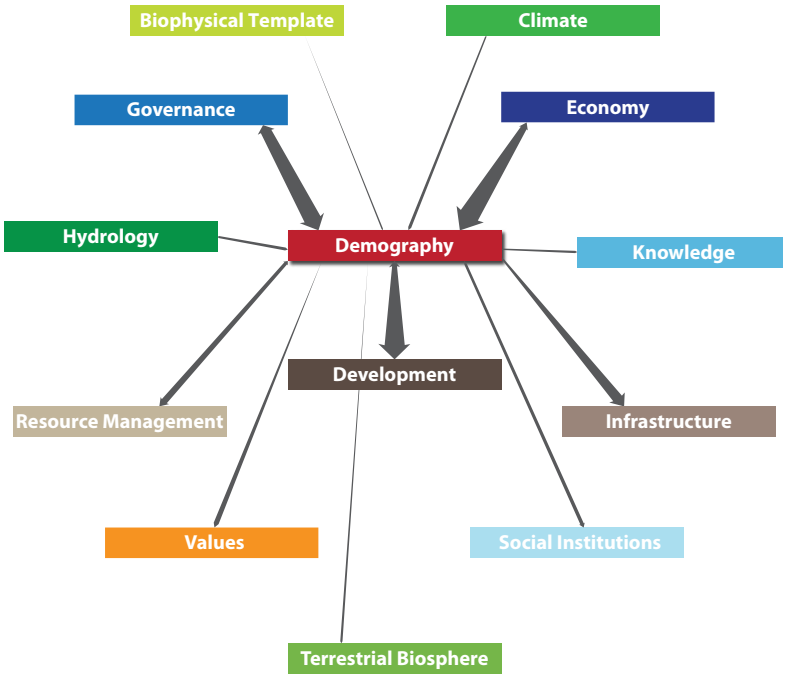
Demography | Biophysical Template

**minimum comment count of 2*

according to our Science Team

Demography

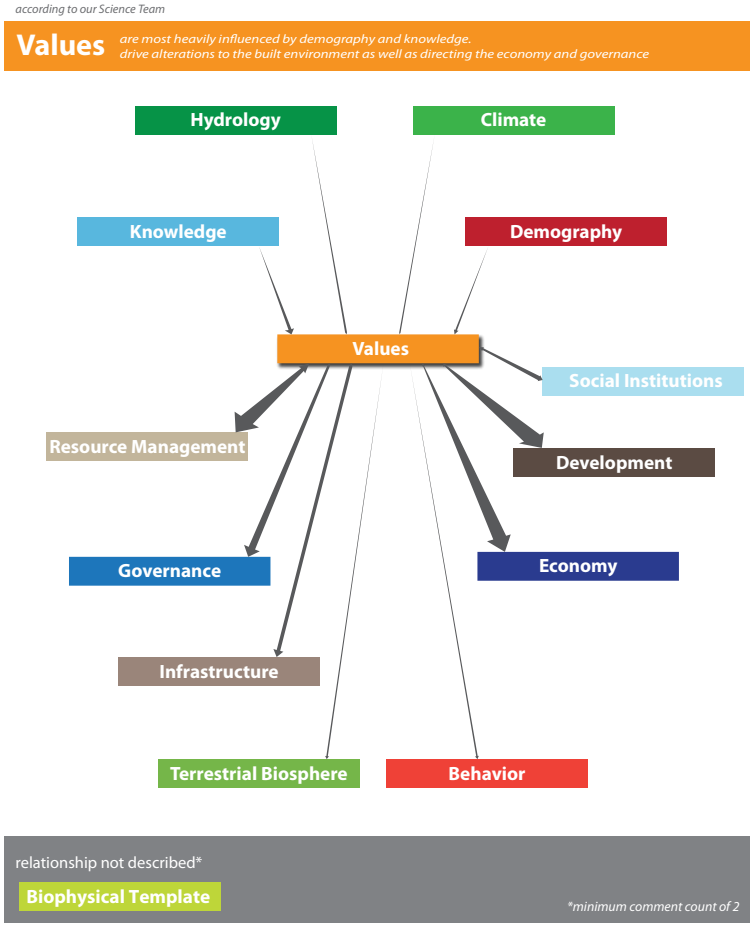
is regulated by governance and economy
drives the built environent with weaker associations onto our values, institutions and knowledge

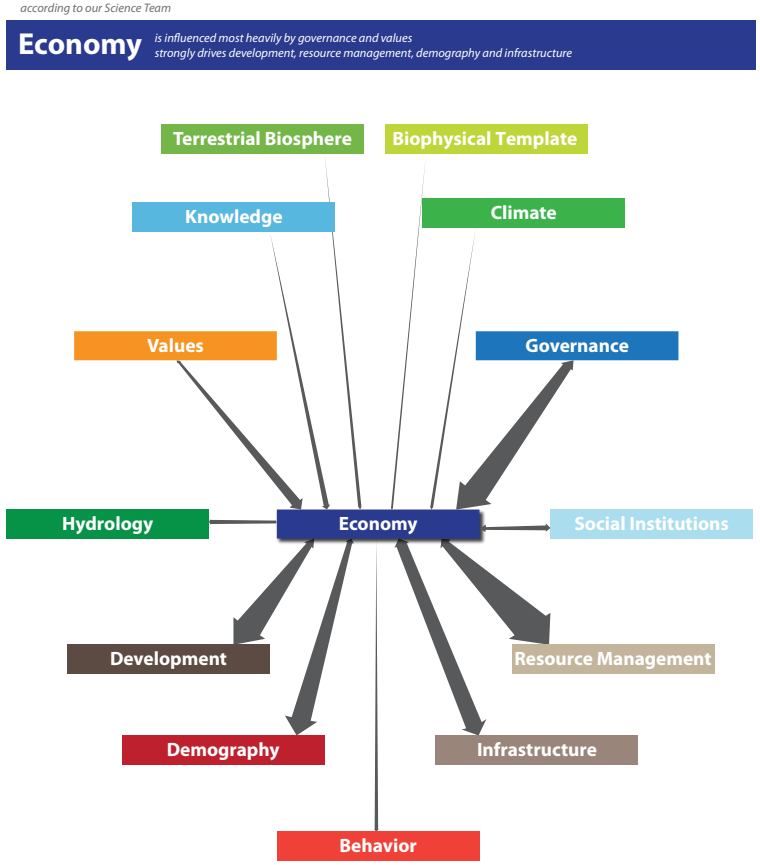


relationship not described*

Behavior

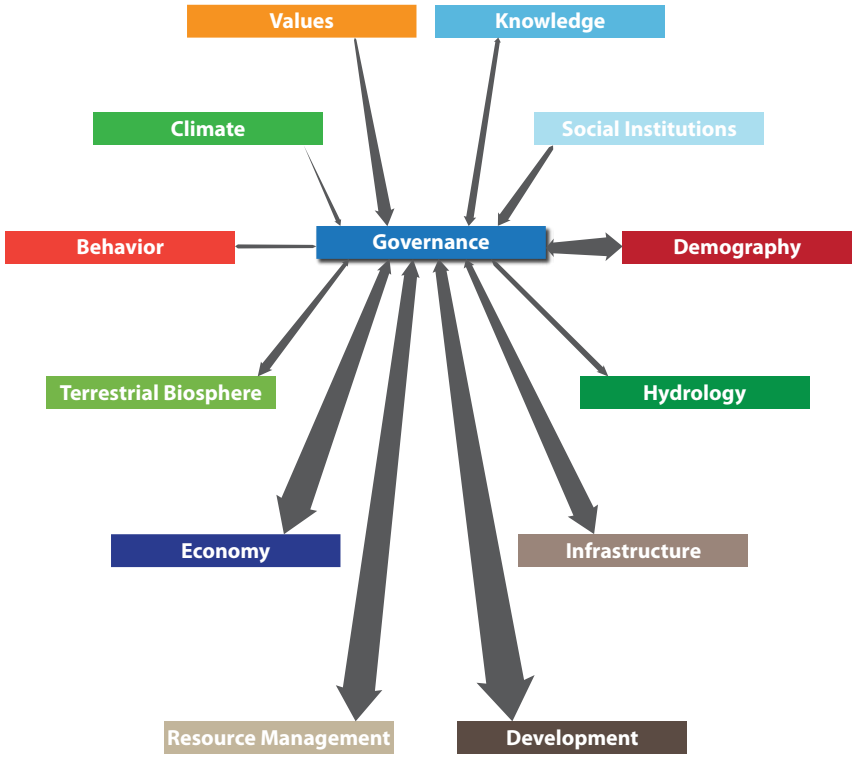
**minimum comment count of 2*


according to our Science Team
Values
are most heavily influenced by demography and knowledge.
drive alterations to the built environment as well as directing the economy and governance
Hydrology
Climate
Knowledge
Demography
Values
Social Institutions
Resource Management
Development
Governance
Economy
Infrastructure
Terrestrial Biosphere
Behavior
relationship not described*
Biophysical Template
*minimum comment count of 2


according to our Science Team
Economy
is influenced most heavily by governance and values
strongly drives development, resource management, demography and infrastructure
Terrestrial Biosphere
Biophysical Template
Knowledge
Climate
Values
Governance
Hydrology
Economy
Social Institutions
Development
Resource Management
Demography
Infrastructure
Behavior

Governance

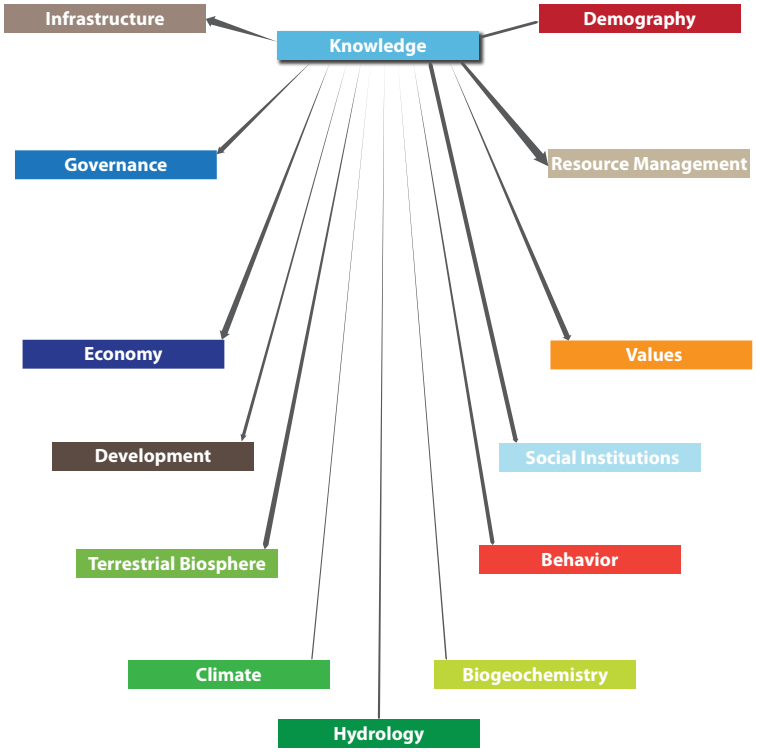
has a bi-directional relationship with most other drivers but is overall considered to have a stronger role as a driver than a feedback, especially its effect on the built environment and economy.



according to our Science Team

Knowledge

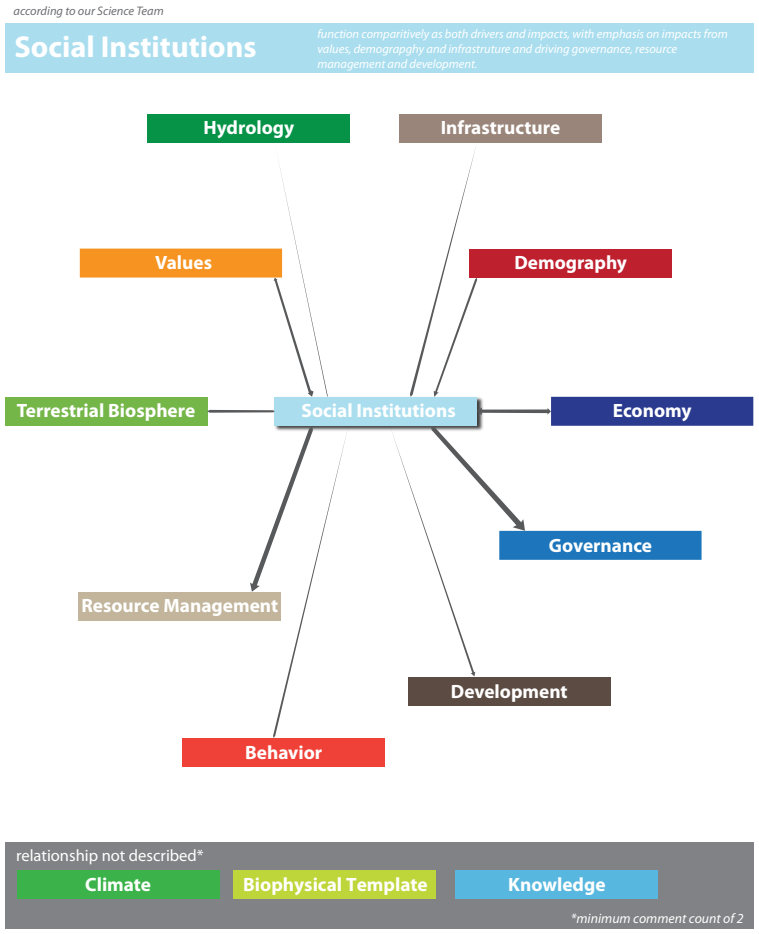
is minimally influenced by demography, social institutions and resource management. drives all drivers with a higher relevace to the built environment and institutions.

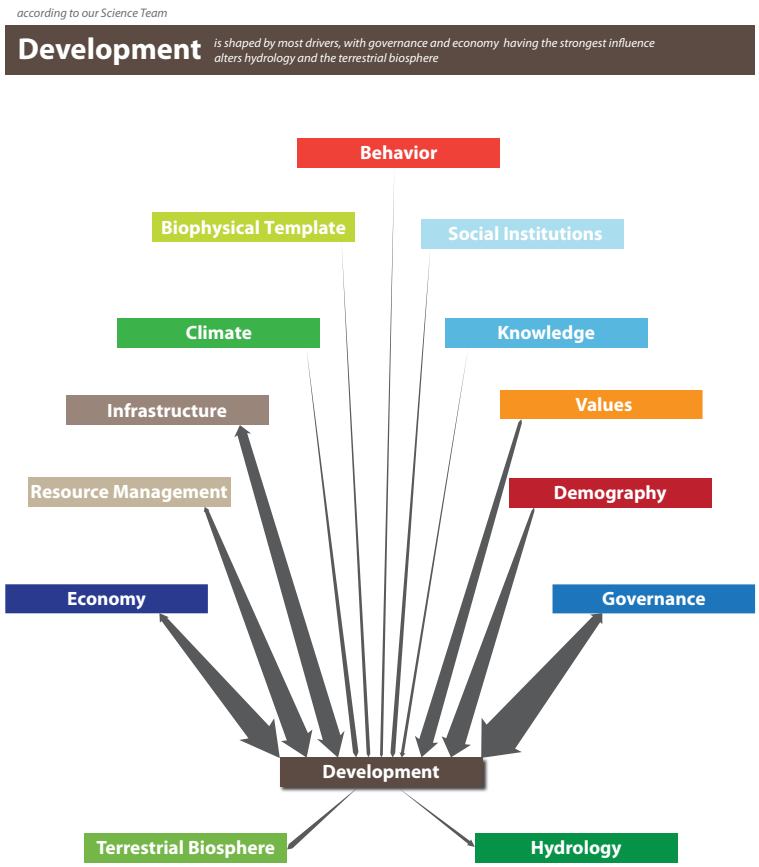


relationship not described*

Biogeochemistry

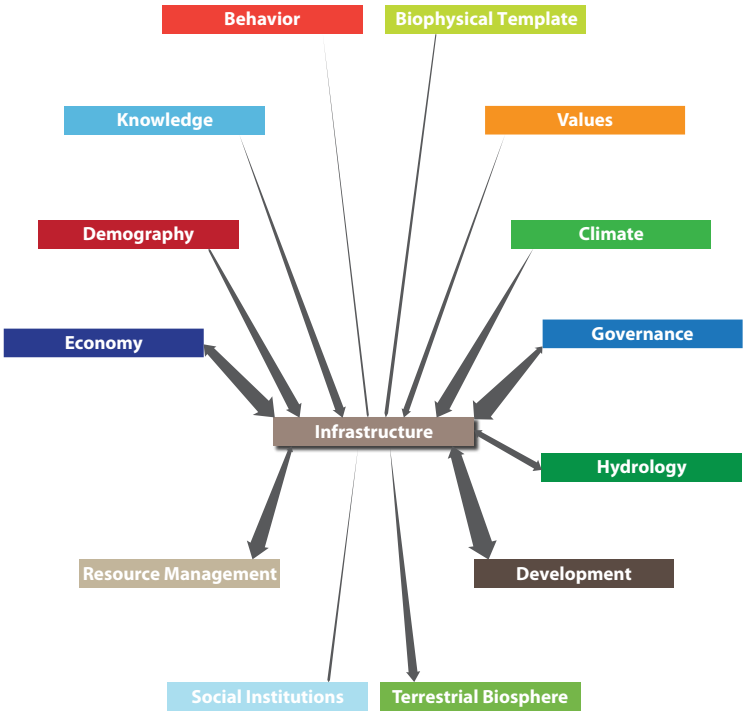
**minimum comment count of 2*


according to our Science Team
Social Institutions
function comparitively as both drivers and impacts, with emphasis on impacts from values, demograpghy and infrastruture and driving governance, resource management and development.
Hydrology
Infrastructure
Values
Demography
Terrestrial Biosphere
Social Institutions
Economy
Governance
Resource Management
Development
Behavior
relationship not described*
Climate
Biophysical Template
Knowledge
*minimum comment count of 2


according to our Science Team
Development
is shaped by most drivers, with governance and economy having the strongest influence
alters hydrology and the terrestrial biosphere
Behavior
Biophysical Template
Social Institutions
Climate
Knowledge
Infrastructure
Values
Resource Management
Demography
Economy
Governance
Development
Terrestrial Biosphere
Hydrology

Infrastructure

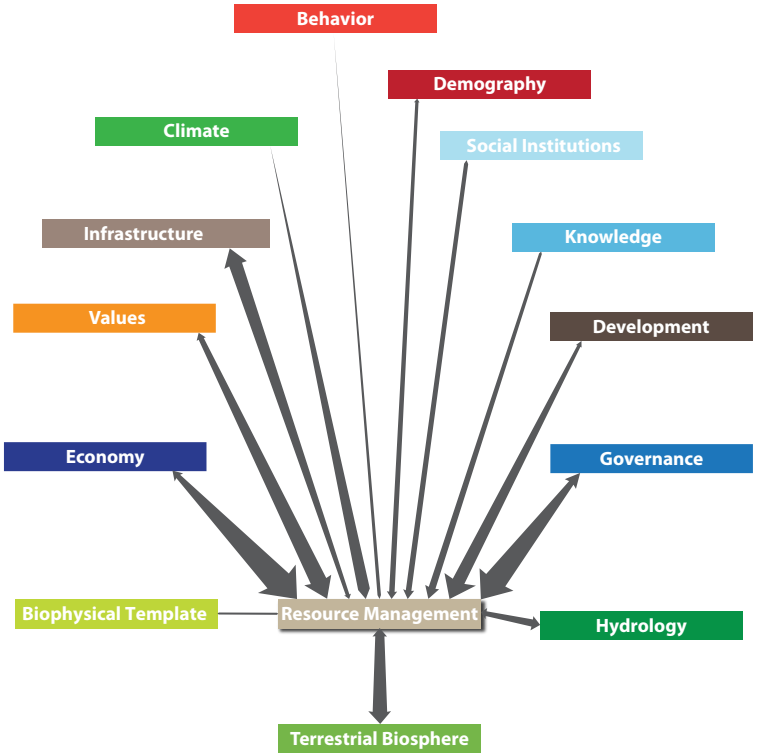
most closely influences other built environment drivers as well as the terrestrial biosphere. is controlled by economy and governance with additional human and environmental pressures.



according to our Science Team

Resource Management

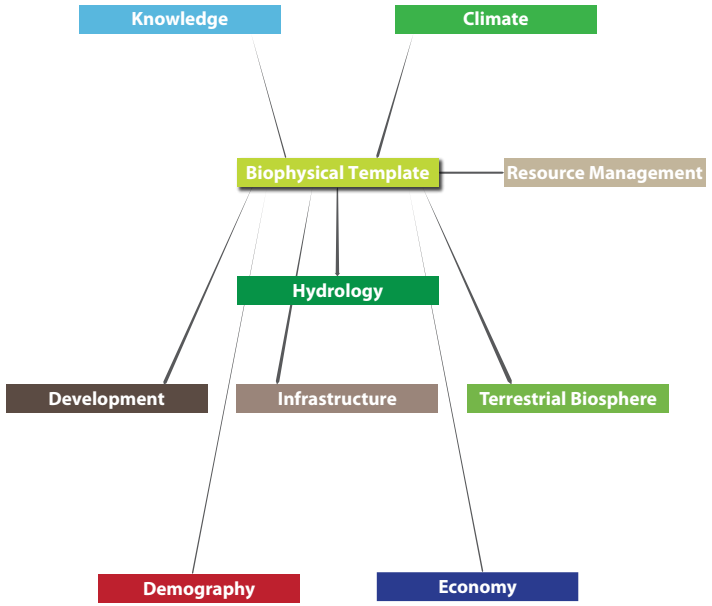
is shaped by most drivers, with governance and economy having the strongest influence. alters the terrestrial biosphere .



according to our Science Team

Biophysical Template

is influenced by climate, knowledge and resource management, drives changes in the hydrological and terrestrial systesm, and shapes development and indfrasturucre patterns.



relationship not described*

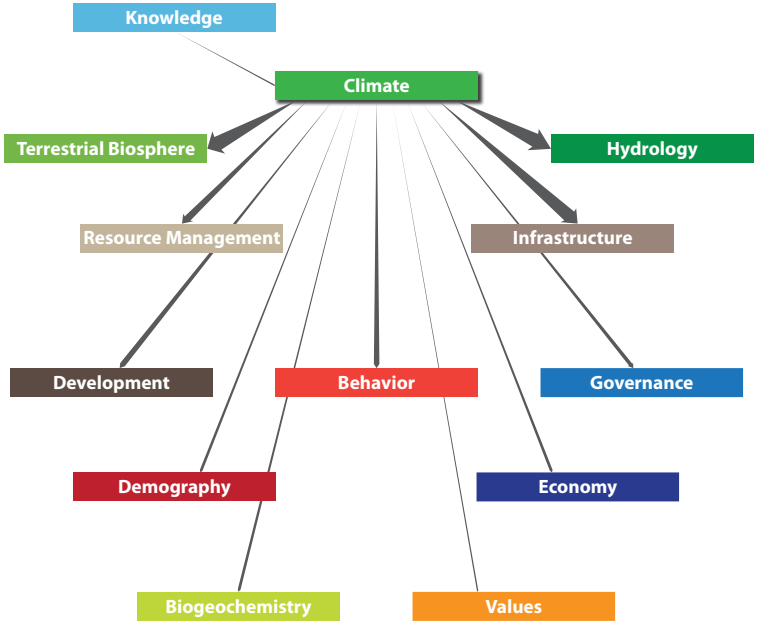
Social Institutions | Governance | Behavior | Values

**minimum comment count of 2*

according to our Science Team

Climate

primarily drives the natural and built environments, with secondary impacts on human and institutional sectors is more remotely influenced by institutions and the built environment



relationship not described*

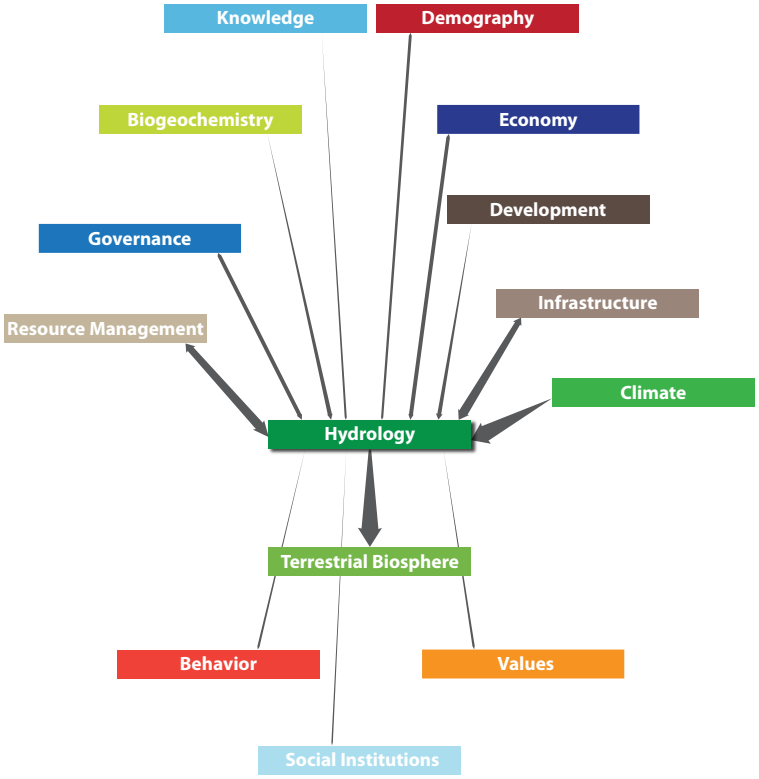
Social Institutions

**minimum comment count of 2*

according to our Science Team

Hydrology

is driven by climate and resource management, as well as infrastructure, development, and governance, impacts the terrestrial biosphere



according to our Science Team

Terrestrial Biosphere

is driven by nearly every driver but most significantly by changes in the natural and built environments. influences economy.

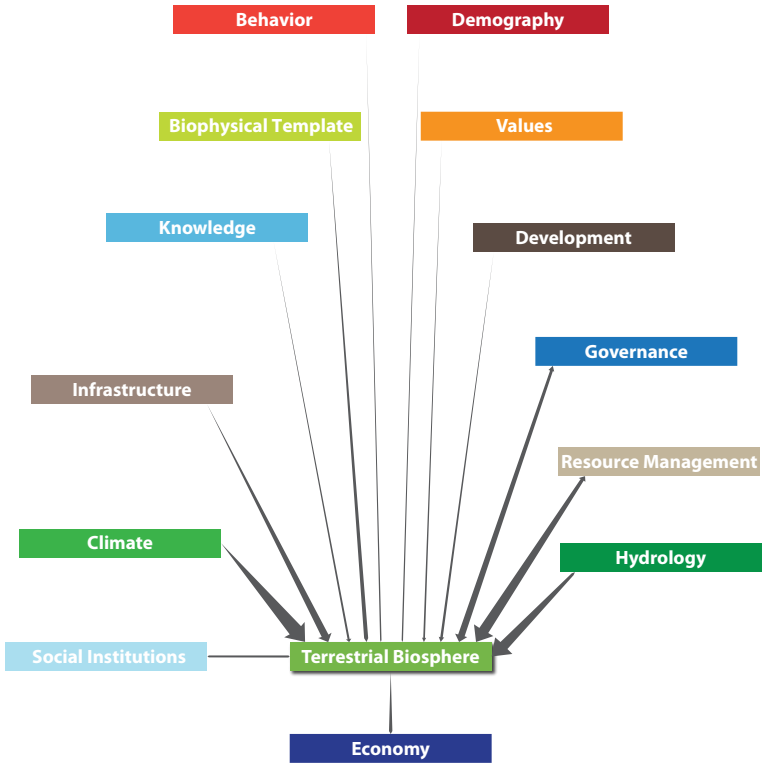


Table A6.1a Relevance Cross Interaction Matrix .The following 3 matrices represent the synthesis of 44 interview transcripts and the Conceptual Model Workshop.The synthesis was conducted by coding transcripts in NVivo and exporting the summary relationship table. The table is intended to represent how various Science Team members view the relationships between drivers. ***Relevance*** refers to how frequently the specific impact was mentioned during interviews and focus groups. The assumption is that the more an impact was mentioned the more relevant it is to consider in the study.The list of drivers is repeated along the top row and left hand side. Cell values represent the number of times a comment was made on on the interaction between two drivers.The top 5% of cell values are highlighted in dark gray. Comments are synthesized and available on the website at: http://www.urbaneco.washington.edu/sbs/images/summary_relationships1.xlsx

Drivers →	Behavior	Demography	Values	Economy	Governance	Knowledge	Social Institutions	Development	Infrastructure	Resource Management	Biogeochemistry	Climate	Hydrology	Terrestrial Biosphere
Behavior	48	1		1	4			4	3	5			1	2
Demography	1	173	7	13	24	4	8	44	25	15		2	3	2
Values	6		131	23	25		9	35	15	42				6
Economy	7	44	6	245	19	1	12	61	39	65		2	8	1
Governance	5	36	3	56	255	7	6	75	41	60	1	2	12	18
Knowledge	6	3	14	12	16	101	9	9	20	21	2	2	3	8
Social Institutions	3	3	6	11	19	6	83	7	1	15				4
Development	1	15	5	16	22		1	195	25	48	2	2	10	8
Infrastructure		3	4	22	14		4	42	186	34	2	2	18	21
Resource Management		8	14	18	24	4	6	9	10	311	3		21	33
Biogeochemistry		2		2				5	5	3	29	1	8	6
Climate	8	4	2	4	9	1	1	8	30	18	4	116	34	37
Hydrology	3	4	3	6	6		2	2	14	16	2		113	35
Terrestrial Biosphere			1	5	9	1	3	2	1	11			4	150

Table A6.1b Uncertainty Cross Interaction Matrix. ***Importance*** refers to how important participants believed the specific impact is. Importance is defined as the magnitude of impact, how wide spread it is, or having a cascading effect.The list of drivers is repeated along the top row and left hand side. Cell values represent the number of times a comment was made on on the interaction between two drivers.The top 5% of cell values are highlighted in dark gray.

Drivers → ↓	Behavior	Demography	Values	Economy	Governance	Knowledge	Social Institutions	Development	Infrastructure	Resource Management	Biogeochemistry	Climate	Hydrology	Terrestrial Biosphere
Behavior	13													
Demography		22												
Values			22										2	1
Economy				43	6			12	4	8				1
Governance				5	33	1		8	2	11				3
Knowledge				3	2	20	1		2	5			1	1
Social Institutions	1			3	1	2	12			2				1
Development				2				30	2	3		1	4	
Infrastructure				7	1			6	34	4				5
Resource Management						1	1	4	1	45			1	1
Biogeochemistry									1	1	5		3	
Climate	2		1	1	1			1	7	1	1	20	4	4
Hydrology	1		2		2				2				15	
Terrestrial Biosphere	1						1	1		2		4	2	16

Table A6.1c Importance Cross Interaction Matrix. ***Uncertainty*** refers to how uncertain participants believed the specific impact is. Uncertainty is defined as questions about the future, expressed by participants by posing multiple future trajectories or stating 'we (or I) don't know how…'The list of drivers is repeated along the top row and left hand side. Cell values represent the number of times a comment was made on on the interaction between two drivers. The top 5% of cell values are highlighted in dark gray.

Drivers →	Behavior	Demography	Values	Economy	Governance	Knowledge	Social Institutions	Development	Infrastructure	Resource Management	Biogeochemistry	Climate	Hydrology	Terrestrial Biosphere
Behavior	11													
Demography		25										1		1
Values			21											2
Economy				54	13	3	3	7	13	17		1		
Governance					49	6	3	8	11	14		1	1	5
Knowledge						29	2	4	8	5		1	1	1
Social Institutions							14	3		6				1
Development				1				40	1	7			1	2
Infrastructure								6	70	18		1	2	9
Resource Management								1	1	66	2	8	1	11
Biogeochemistry									2	2	7		2	1
Climate	2	2		1	4	4	1		12	8	2	45	7	21
Hydrology			1	1	3			1	2	3	2		15	6
Terrestrial Biosphere			1	2	3					4	1			44

Behavior's *Relevance to the Basin*

Can we adapt: Experts discussed human ability to adapt. For example, 'can we get out of our cars?' and 'can we adapt to technological advances?' We discussed the impetus for adaptation, whether reactive or proactive; for example, will climate change force us to change our behavior?' or perhaps a major hazard. Also, the direction of adaptation; whether towards needs or desires, going green or towards self reliance, defense, or evading regulations.

Changing consumerism: Human consumption was discussed as both a driver of resource needs and as an impact of values and the economy (the market). Discussions generally mentioned changes in 'what people buy', 'human use' and 'increased demands'. Specific consumption patterns included conscious consumption (the active decision to consume less) and energy consumption.

The Human-Nature Dimension: How we interact with the nature is continually changing. Participants discussed legacy of dumping, or 'dilution as the solution' and more generally human footprint and the change we leave behind. There was also discussion of our connection to nature, and how technology or values can influence that connection.

Investment choices: What we choose to invest in or 'where the money goes' was discussed as a component of human behavior. For example, whether we purchase new items or repair existing materials, whether we create subsidies for responsibility and invest conservation versus HazMat cleanup.

"importance"

13 ***comments***

The difference between Western and Tribal culture has had a major impact on behaviors in the Basin.

There has been a huge shift in our the types of chemicals we use, in residential, commercial and agriculture.

History is of critical importance to apply better decisions in the future.

Human use is an important category.

The shift from industrial to service economy has altered people's habits dramatically.

Before you could dump a load of rock in the river, now there is a lot of oversight.

Global climate impacts will become a more dominant impact in how we live.

A major hurdle is people don't adapt very well.

Impacts associated with recreation are minor compared to other impacts of human behavior

It's about getting the information out so people can modify their behavior

"uncertainty"

10 ***comments***

Perhaps in the future we will have more respect for what we have because we will have less?

There is a lot of uncertainty about near and long term affects of climate change on our choices to adapt.

People can get really creative in the face of disasters.

Self reliance could take many forms, maybe living off the grid or heading out to bunkers with AK47s.

I have seen models of zero growth, but can humans control themselves that much?

The green movement and conscious commitment to consume less may later trajectories.

What is our ability to adapt?

Going green will depend on government incentives

Are regulations so heavy the public rebels?

How will people adopt and interact with new technology?

Demography's *Relevance to the Basin*

Characteristics

Aging Population: Over the next fifty years the Basin will experience a significant change in age structure. The average baby boomer is 65 today, and the average farmer is 58. This population has shaped policy in the Basin and they will be gone by 2060. The Basin will likely see significant changes in service demands, average working age and development patterns associated with retirement and changes in preferences.

More Diversity: Experts agree that the Basin is becoming and will continue to be more diverse. Diversity has doubled since 1990s and we are expecting to see a 50% increase between 2000 and 2010 (when the census data comes in). Changes in diversity are not limited to ethnicity, we have seen changes in age structure, income, disability and other characteristics. Forecasting to 2060, many experts believe we will see more inequality and social segregation alongside the growth in diversity.

Exporting Education: Educational attainment in the Basin has increased over the last half decade, largely coincident with the Boeing rush and influx of skilled labor. While children have higher achievement scores, the Basin exports students for enrollment in four year colleges.

Greater Income Disparities: Over the last fifty years the Basin has been influened by higher income jobs. In the future, many experts discussed growing disparities in income and challenges associated with poverty, service provision and segregation. Poverty issues include homelessness, employment instability, overcrowding and lack of health care access. Community disengagement associated with wealthier households can lead to gated communities, privatization of services, private security and lack of funding for schools, libraries and social services.

Growth

Unchecked growth: Population growth was one of the most frequently mentioned human factor when discussing change in the Basin. Population growth was a determining factor not only in how the Basin is what it is today, but also how it will change in the future. In the last decade, Snohomish County was the fastest growing county in country. Overall, there was almost unanimous agreement that the Basin population will continue to grow, though many questioned the benefits of unchecked growth.

Fluctuations in Migration: Fertility and mortality have been stable for the last few decades, therefore while they can affect population growth, migration (both in and out) is a more significant factor determining changes in growth rate in the Basin. Jobs largely determine migration rates and the Basin has seen growth in both high income residents working for high tech or green industry jobs, as well as Spanish speaking migrant workers associated with the agricultural community. Lesser migration trends are associated with international immigration policies and academic outmigration (for higher education). The Basin's quality of life associated with proximity to Seattle, growth management policies and natural resources is considered an important factor in the decision to relocate (for both residents and employees).

Health

For Better or for Worse: While some experts discussed improvements in human health, associated with better access to health care and longer lifespans, others mentioned deteriorating health conditions dueto obesity and water quality issues. Current topics reflected local food movement, air and water quality standards, and psychosocial benefits associated with relationships to nature. Future concerns focused on climate change (both temperature and virology), increase in population (overcrowded) and change in economic conditions (income disparities and lack of funding for social services).

"importance"

17 ***comments***

The demographic shift caused by software development has been a big part of change in the Basin.

Population is the biggest difference in a whole bunch of different things, it's not just the number of people that matters.

Population growth will continue, we won't be able to constrain it.

Population growth is huge, it drives everything.

Public perception of food safety is important.

Sheer population numbers are important.

I think growth is the number one driver, it impacts on everything.

There has been incredible population growth.

The primary difference (out to 2060) would be population growth.

Impacts are measured as a systematic assessment of incidence on people, the economy, property and the environment; all four factors are correlated to population growth.

Human population growth is the largest issue we need to deal with.

The influx of people altered the motivation for development in a profound way.

Migration drives change.

"uncertainty"

19 ***comments***

We may see more people as well as older people.

There are a lot of challenges in front of us due to population growth.

A question still remains on how to transition farmland to the next generation.

The University of Washington could be private and only the wealthy can afford to attend.

I question that we will always increase our population numbers. There has to be a tipping point.

What happens with the aging population?

What are the legacies of past population growth?

How will air quality influence health?

The Puget Sound Region is a magnet for bringing in people, the question is will they end up in the Basin?

If the economy remains depressed and Boeing doesn't stay, and farmland is turned into subdivisions, will poverty rates be much higher in 50 years?

Recreation trends are changing, perhaps due to Americans becoming more overweight.

The major question is: will we see change back to growth once the economy recovers? The situation is currently difficult to read.

Values' *Relevance to the Basin*

Respect: Most experts discussed beliefs in association with implications on management and consumption. For example, "perhaps in the future we will have more respect for what we have, because we will have less". Topics included past values movements such as the 'depression mentality', the 'environmental movement', 'conservation ethics' and 'a connection to the environment'. A more recent value shift corresponded to 'a commitment to the Basin' (and the importance of appearing committed as a market value). Religious or ethical topics related to Tribal and Western thought. The majority of discussion related to changes in 'how people look at things' influencing conscious consumption and environmental impacts. Future value changes include faith in government, interest in higher education, apathy about privacy issues and acceptable norm (i.e. recycling grey water).

Doing things right: Participants generally saw preferences as arising from new knowledge and with potential influences on setting the public agenda. Several participants discussed a willingness to 'do things right' defined variably as accepting more growth, embracing the urban lifestyle, advocating the protection of the River, personally donating, funding change, and discussing the environment.

Protecting a high Quality of Life: While a higher quality of life (QOL) may be an obvious shared objective, defining what is a higher QOL is highly subjective. Participants shared ideas that the Region's natural resources support a high QOL, which simultaneously should be protected and draws more people here. These valued amenities relate to an urban-rural tension; namely the desire of the urban community to protect ecosystem services and recreate in natural areas while maintaining an affordable cost of living. The agricultural community has seen market changes related to this preferece, including an increase in demand for local, grass fed beef and organic produce, as well as personal interest and participation farms and the farmers.

Shifting norms: Norms have shifted dramatically and the clearest example is that of a smokestack once depicted as a positive sign of industrial production (i.e. jobs) to now a negative health factor. Other examples include seeing the river as 'owned by industry' to that of a public recreation amenity or seeing farmers shift from being seen as "dummies" to "heroes". Changes in these perceptions influence market values and acceptable production modes, with examples including the Spotted Owl controversy, GMOs, recycled water at Brightwater. There is uncertainty in regards to future norms, for example, will passive management be the preferred forestry management in Wilderness Areas if we have a major fire? Will aging households downsize? Will we regain confidence in lenders? Will our ideas of what is "built out" or capacity change? There is the hope that we will shift towards longer term thinking and be more proactive. And there is the fear that we will become meaner, associated with a larger income gap and increased anxiety over security, power and limited funds.

Raising awareness: Awareness was discussed in relation to 'making the right decision' (generally through outreach). The sentiment was the public officials and the public need to become more aware of a number of issues in order to influence behavior. Issues included importance of local food (agriculture), ecosystem services, and floodplains, as well as the implications of uncontrolled growth, climate change (and the need to reduce emissions), fractured ownership (of forestlands) and privatization (of services). The general public was credited with a better understanding of the inter-relationships of our actions and the need to strategize on a larger scale (i.e. the green building community looking beyond solar panels and towards neighborhood-scale strategies). Perhaps less so is the credit to the public understands of lag times (between action and impact).

"importance"

23 *comments*

The difference in perspective between Tribal and Western thought has led to a lot of differences in management.

This land is beautiful and people expect to drive out and see it. Its important to them.

Values drive everything.

How we value agriculture? Collectively we will agree agriculture is important.

Quality of life is very important

Flooding and rivers will play a huge role in what people think is important for their quality of life.

Changing people's perception is a major factor.

We are perceived nationwide as having an abundance of pristine habitat.

Expectations are an important category.

Change revolves around people and the economy.

Attitudes have changed. Social expectations have changed. People think they have control, they would have been told to mind their business back then.

Privacy is a huge thing. It's a huge motivator.

How do we get society to pay for these values? To keep the forest forested?

It ends up being about our thoughts.

Another driver influencing change is personal choice and how people's attitudes change.

"uncertainty"

20 *comments*

Perhaps we will have respect for what we have in the future, because we will have less.

Public perceptions can change agricultural practices from reactions, such as the reaction to growth hormones in milking cows.

The use of reclaimed water, for example, is controlled by human perceptions.

How do we value agriculture?

How do choices like those of the aging population influence the market?

How do lag times, between impact and ecological effect influence land manager perceptions?

We will want to make the changes but will we have the funds?

People will need to make choices for urban development and to protect forests.

I couldn't bear to live in the City, but maybe a shift toward urban living and driving out to rural areas to see the wildflowers is coming?

Issues of the day, like the avian flu are ephemeral in our focus and hard to predict.

What would a changing demographic be willing to pay for? Not just demand.

Is it possible to learn about the importance of forests and where materials come from?

We may see the concept of reusing wastewater take hold. We will see a continued consciousness.

Economy's *Relevance to the Basin*

Dwindling Funds: Across the board there is less funding and more demands, and we are challenged to find new ways to pay for all the thing we love. In terms of municipal funds, or public budgets, we are seeing more layoffs, closure of programs and efforts to increase efficiency as means of combating insufficient sales tax revenue. The three main opportunities for funds are business revenue, privatization of services and infrastructure repairs. The era of new grandiose municipal infrastructure is over, and we are seeing more of the European model of repair and mechanisms for increased efficiency supported by federal funds such as stimulus or congestion funding.

Shift from resource to service: Over the last fifty years the Basin has changed dramatically from largely resource based (timber, fishing and dairy) industries to manufacturing, technology and service based industries (Boeing, health care). While somewhat diversified, aerospace and Microsoft dominant the cash infusion into the. Economic forecasts rely on global industry changes to predict industry growth, including the cost of oil, recessions, industry organization, telecommuting, research + innovation, global competition, multinational trade, and recovery efforts.

Staying competitive: Associated with changes from resource, military and manufacturing to technogloy and service based jobs those jobs are demographic changes in family structure, gender, diversity, age and educational attainment. The Basin has, until recently, surpassed national averages for job growth. This growth has not always been well planned or coordinated and has challenged the provision of governmental services and economic saliency of incorporations. Potential future challenges will include the ability of the Basin to compete globally and within the Region to maintain and attract jobs through 1) amenities and high quality of life for employees, 2) predictable and fair permitting standards and 3) skilled and affordable (via effective negotiations) labor.

A Green Market: Conscious consumption and market demand, or lack thereof, for 'green' or environmentally safe products in the Basin may be reflected in higher density housing, carbon neutral developments, smart metering, rain barrels, on-site waste treatment, local agriculture and diversified crops. The market is often realized at a global scale by influential determinants such as gas prices and the energy market, privatization of services, the national economic climate and global trade. Global shifts then influence the Basin including effects on the role of aerospace, salmon fishing and local ag products.

Wealth Divide: As the industry shifted from resources to services, the level of personal wealth in the Basin rose dramatically. Today we see higher shares of disposable income affecting land use decisions, like the popularity of ranchettes, small scale tree farms, double income 5-acre farms and very large residential homes. On the other hand, for farmers, frequent floods and heavy regulation challenge profit making. The Basin continues to house lower income households, and in many ways the gap between the wealthy and poor is widening, with future implications on the privatization of services, affordable housing vs. gated communities, direction of recreation, and inequalities in health.

"importance"

27 ***comments***

the National economic climate changes everything; it influences the amount of conservation efforts that can be accomplished, what people can buy, where the money goes.

Peak oil production will influence the price of oil which, will wreak economic havoc and uncertainty.

Up here in Snohomish we are very reliant on Aerospace. It's not healthy, but it supports us.

Trade and port activity is important!

Regulatory oversight has increased significantly, leading to substantial economic burden on industries (including farmers).

Quality of life is important, but trends correlate most strongly to jobs.

Biggest challenge will be staying competitive against growing countries like China.

Changes revolves around economy and people.

The biggest on-the-ground change is that there is a far broader diversity in job centers, with many new job centers sprouting all over the Region.

The shift from an industrial to service based economy has changed people's habits dramatically.

Funding, money, is a major issue. It's what it all comes down to.

Recreation is a huge industry here that is still largely unpaid for.

Employment is a big driver in the Puget Sound; if we lose Boeing or Microsoft we could see less people leading to less pressure on resources.

"uncertainty"

24 ***comments***

Perhaps in the future we will have more respect for what we have because we will have less?

Will the economy be restructured so we get more local productivity? Will we be forced into that?

There may come a time when you don't have to live where you work. What might that do to Basin culture?

Will we become wealthier?

Business and economy is an uncertainty.

I would be surprised if Boeing was around 50 years from now.

Perhaps in the future subsidies will be different, like the Farm Bill which shaped agriculture.

We assume the economy will continue to grow, but how much growth can the region sustain?

What comes out of the labs and how industry is organized are uncertainties governing future industry growth in the Basin.

There will be good information. We will want to make changes. Will we have the funds?

The hope is that we will continue to generate employment but reduce impacts at the same time.

Going green will depend on how effective we are with government incentives.

Perhaps we will become a manufacturing center again.

What will be China's role in our economy?

With economic distress we may see incorporated areas dissolving back into counties.

Governance's *Relevance to the Basin*

It's political! Politics was loosely described as an uncontrolled shifting variable as in, politicians don't want to pick a side, or leave it to policymakers, the challenge with turnover of politicians, or depending on the shift in partisanship, or the political situation, etc. Alongside this uncertain shift were a few discussions of credibility, especially associated with the 'farm fish debate', coming from both the side of scientists disillusioned with assessment of habitat and farmers frustrated with costly and cumbersome regulations. Specific institutions were discussed at various scales, including 1) federal regulators such as EPA and FEMA, 2) Washington State agencies including the PSP, DOE and DOT 3) the Counties, 4) the Tribes and 5) municipalities. Overall, challenges discussed included the need for coordination among jurisdictions, the importance of government in pushing the public agenda (or any visionary agenda), and the impact of changing funding sources.

Level of services within municipalities and at the County level can determine where people choose to live, and where industries choose to locate. Over the last 50 years we have seen significant increases in wastewater and sewer treatment, access to health care, police, libraries and fire service within rural areas of the Basin. While expectation of services rose, many incorporated areas can't balance increasing demand (residential population) with lack of new funding leading to declining LOS. Economic hard times exacerbate difficulties, increasing the gap in access between wealthy and poor populations. Further, it is during these hard times that social services for the poor are at the highest demand. Changes in family structure, non-English speaking populations and dominant industry sectors may change the needs of the population.

Growth Managment: Over the last 50 years, we have seen a major policy overhaul increasing the complexity of regulations governing new development with the goal of protecting natural resources. Perhaps the most significant in the Basin have been the implementation of the Growth Management Act and Forest Plan. The allocation of funds, including Federal, State and local taxes has been, and continues to be a major driver of GM. Incorporations were cited as a way to get State funds, but also as a challenge in maintaining sufficient funds for service provision associated with different land use patterns (housing vs. commercial). Experts frequently mentioned how some counties have more stringent or effective rules governing management than other Counties.

Stringent Regulations: regulations have been seen as becoming a larger obstacle to profitable industry: banning the dumping of certain pollutants, referring to the Spotted Owl and decline in timber industry, and the predictability of the permitting process deterring new industries from forming here. The public agenda has also changed, especially with new development alongside agricultural lands and forests. This was most commonly described in terms of changed expectations for harvesting, viewsheds, access and safety, as well as changes in participation and trust of government agencies. But the most frequent discussion revolved around policies impact on agriculture associated with the protection of riparian areas for salmon. Farmers, described a need to subsidize agriculture and clarify definitions. In the future, new policies will need to be revamped to incorporate new knowledge and values around climate and sustainability. Experts also mentioned future changes associated with changing housing policies, new pollutants, and potential new listings.

"importance"

34 ***comments***

Growth management encourages incorporation, then the County needs to bail out municipalities.

Turnover of elected officials is a major challenge.

The health of the Puget Sound water will drive regulations.

There will be little progress in constraining development.

Regulatory oversight and bureaucracy have significantly increased.

Regulations in general have a high cost. A new listing, for example, could lead to the elimination of farmland.

The EPA wasn't here 50 years ago. Federal government has caused a big shift in who you talk to about your problems.

Salmon decline is huge! Our tax money is going into analyzing and solving the problem, educating the public and court battles.

The expectation of services is an important category.

Accommodating growth is the focus now.

We are on the cusp of major changes in housing policy with huge implications on directing growth.

The public will lose interest and faith in government if we don't make enough progress. This is a big issue.

Zoning is a huge issue. Drawn on county lines and difficult to predict. As population goes up, zoning can drive up the revenue stream.

Wilderness act led to a profound change.

"uncertainty"

48 ***comments***

Biggest uncertainty is on emission and energy consumption, which is influenced by national and state level policy.

Are rules such as the Critical Area Ordinance being enforced? Are they even effective?

What is missing from public policy to keep Boeing here?

How do local versus federal subsidies affect control and support?

Can emerging environmental markets protect agricultural land better than draconian land use laws?

Democracy in this county could have a serious shift towards defense.

There could be a shift to the federalization of environmental management.

We could have great cities, we could do these things, but will we? The major question is political.

We have yet to see our track record with the GMA. Does it prevent sprawl? What will it shape growth? Can we stick to it?

Going green will depend on government incentives.

We have to remember the goal behind all this is to protect resources. The question is, are the regulations too heavy so the public rebels?

What is the future role of county government?

How do we craft regulations to meet the changing needs of smaller scale farms with a higher diversity of products?

Knowledge's *Relevance to the Basin*

Predicting innovation into the next fifty years is a major challenge. After all, fifty years ago the personal computer was not around. We expect there will be more of the innovations we have seen in the past: advances in medicine, increased land productivity, automation and efficiency and reductions in costs. As far as new innovation direction, one certainty is increased energy efficiency and lower reliance on fossil fuels. We are expected to close the waste stream loop (eliminate pollution) and identify new technologies to help us go faster and further (shale gas, sonic boom travel, distributed solar power, cellulose, electric cars). Lastly, if the past has taught us anything, it's that technology always comes with unintended consequences. Recent challenges include: a hyper culture where twitter replaced deeper 'friendships', short term memory loss due to instantaneous access to information, virtual entertainment replacing contact with the natural world, and recreation gear (bikes, lightweight backpacks, all season garments) increasing access to pristine areas.

The role of science: Scientists are gaining new knowledge about the complexity of issues influencing the human-natural environment. We have seen a paradigm shift from understanding local impacts (industrial pollution) to cumulative impacts (impervious surfaces) and remote impacts (global warming). There is also increased awareness of thresholds, pollutants, biodiversity and resilience; though most experts agree our knowledge is still limited and always unfolding. With remote data we are able to conduct larger scale observations at lower costs, increase the density of our observations and monitoring, and improve the visualization of data. However, whether this has improved resource management or the accuracy of understanding is still up for debate. Lastly, distributed technology has revolutionized where the expertise lies. Experts now work directly with the public to identify and understand restoration actions.

Public outreach: A corollary to what we know is the communication or sharing of that knowledge through teaching. Experts, especially in the government and non-profit sector, believed that public outreach is critical to raise awareness and change behavior. The Tribes are an interesting factor in the Basin, with a unique long term perspective and mechanism for passage of knowledge. Technology, visualizations, assessments, farmer education programs and marketing were all mentioned as tools for communication.

"importance"

21 *comments*

New energy technology could be a big deal.

The assessment of the Snohomish Basin is of critical importance as the four rivers here determine policies for the rest of the State.

The sharing of cultural knowledge is important; an awful lot to learn.

There is a global value to biodiversity that science hasn't fully determined yet. It's like throwing out books without looking inside them first.

Technology is major predictor in terms of the future role of industry. What's coming out of those labs.

School and education are important in the recognition of historic conditions.

Convincing people to make the right decisions. It's a major factor.

Getting people to understand history and apply lessons to better management decision in the future is of critical importance.

Its important to save what's precious, but we need to understand the drivers. We need to improve our knowledge and pay attention to history.

The rise of digital data will be very important in the future.

Teaching the next generation to unravel some of the problems we have already created.

Its about getting the information out so people can modify their behavior.

We may see more technology on a personal level. This will be a big game changer.

Knowledge and development drive economic growth.

"uncertainty"

28 *comments*

Uncertain about information technology's future.

We may become aware of pollutants that haven't been identified yet.

Technology change, what will be invented?

In the future, will we recycle everything?

What is the value of biodiversity?

What changes will technology bring to our lifestyles? Will we commute?

Hard to predict what's coming out of the labs.

Climate model predictions are uncertain, especially in their evaluation of the effect of water

Our current understanding of steelhead population is skewed. How many orders of magnitude off is our understanding of the richness of how our environment was?

Will we recognize, as a society the maximum number of people the Basin ecosystem can hold? Will we understand thresholds?

New reports may alter regulations and policies, especially around carbon.

A potential future tool will be technology to visualize impacts.

Could we shift through technology to a different zero discharge community?

Will outreach teach the importance of forests? We all learned to recycle.

How will people interact with technology advances? Will the communication network promulgate virtual commuting?

Social Institutions' *Relevance to the Basin*

The rural, the urban and the recreation: Participants loosely described 3 communities in the Basin: the rural resource based community, the urban (largely residential) community, and the recreation community. The rural community has been shrinking, meanwhile intensifying its importance and cooperation with neighbors. Many participants described a growing contentious divide between urban and rural communities as urbanization pressures increase. The residential community is shifting away from inter-dependency and towards self-sufficiency. Meanwhile, the recreation community is growing significantly.

The New Tribes: Over the last 50 years, the roles of both the Tulalip and Snoqualmie Tribes have changed dramatically in terms of both culture and rights. The Tribes are increasingly seen as influential actors in the Basin, especially in the realm of natural resource protection. Native Americans share cultural norms that are uniquely different from Western thought and have influenced their management perspective for centuries. Despite massive social casualties from direct attacks, disease, and loss of land and resources (i.e. salmon) the Tribes have witnessed a renewal and livelihood. This renewal can be attributed to a heroic reconstruction of culture, a cash infusion brought on by the casinos, and recognition of tribal rights (Boldt Decision). Despite significant progress and investments towards cultural sustainability, infrastructure and resource management, the Tribes struggle with future uncertainty in regards to salmon and ecosystem service provision as well as the generational passage of cultural lessons and skills.

A lost culture: Overall, participants discussed a fear over the loss of ties to the Basin's natural and cultural history. Most discussion revolved around the Tribes and farming heritage. Further, many experts brought up the influence of technology, shifting the pace and accessibility to influence changes in work/life balance and social interactions. Other cultural elements included the increase in Basin cultural diversity, the competitive advantage of Seattle in terms of opportunities for arts and humanities and the influence of costs as overriding cultural preferences.

Globalization: An overarching driver of change in the Basin was global change, or more specifically the influence of other countries on the perception, economy and policy in the Basin. The competitive advantage, due to lower costs and increasing skillsets, of the developing world was discussed in terms of retaining global industries (Boeing, Microsoft) and attracting new innovation jobs. Global policy, including regional barriers multinational trade, anxiety of loss of US power and displacement of global refugees (due to political unrest and climate impacts) was sparingly discussed.

Public engagement: The two topics discussed as polarizing public engagement include density (the public being for it, or against it) and natural resource protection (relating to how connected to nature the population and presence, or lack of groundswell movement to protect it).

NGOs chip in: The increasingly important role of Non-Governmental Organizations is working to bridge the gap between landowners and County government. Environmental groups are supporting the protection of natural resources through large networks of volunteers. Otherwise, activism and engagement in civic organizations while not carrying the groundswell importance it once did, still shoulders the interest and attention of Basin stakeholders.

"importance"

12 *comments*

The difference in perspective between Western and Tribal culture has led to a lot of differences in management and behavior in the Basin.

Heroic reconstruction of culture and language of the Tribes.

Tribes play an important role.

The Tribes are a bigger factor now, both in managing resources and treaty rights.

Tribes are influential.

Biggest challenge will be staying competitive against growing countries like China.

Political will determines a lot.

Political will and developers are very important drivers.

A major hurdle is societal resistance to change.

Fish and culture are important things that lead to joint decision making

"uncertainty"

15 *comments*

There may be a time when you don't have to live where you work. What might that do to Basin culture?

Will we, as a society recognize and make the choices in regards to carrying capacity and thresholds?

The Tribes are trying to improve and sustain fish population. Perhaps by 2060 all of Snoqualmie will be protected.

Perhaps in the future the Tribes can educate the community about their culture and show their good will. The hope is their will be more influence.

We could have a large terrorist attack. We lie at the border of Canada and the Pacific Rim.

We could see the rise of an increasingly radical population in the Middle East that are extremely technologically savvy and very angry.

There needs to be a willingness to see cities change.

People will need to make choices for urban development and to protect forests.

There is an ebb and flow of public engagement that can be very influential but is unpredictable.

Perhaps we will become an international manufacturing center again?

What will China's role in our economy be?

Development's *Relevance to the Basin*

The Urban-Rural Divide: The Basin is described as 'fractured along the rural and urban divide; old residents don't like the urban change while new comers connect more with Seattle, than their new farming neighbors'. New applications for development are mostly for converting forests to 2-5 acre homes. And while movement is into rural area, residents are also looking for urban amenities such as parks, employment, services. Further dividing the population, new upland development is seen as detrimental to lowland agricultural practices and sustainability of Basin forests. Zoning has the potential to control character but is largely criticized as counter-productive. Construction techniques are shifting towards mixed use, higher density, transportation networks and low impact development.

Housing: In the past, residences were associated with the resource industries, but as Boeing and Microsoft came to the Basin, residences changed accordingly. The automobile is major determinant of residential growth today. Conversion of larger parcels of undeveloped land is controlled by land values and regulations. The rate of conversion is shaped by the high value of housing, in contrast to timber and agricultural lands, and the increasingly burdensome role of County permitting. In the future, we may see, increasing residential intolerance of resource based industry, increasing income inequalities, aging households migrating back towards services, and a shift towards green-high density houses.

Locations of growth: Growth is slated to be focused West of the Cascades, along I-5, with rural infill in the northern portion of the Basin and urban development south of I-90. We are likely to see density at the intersection of I-9 and Route 2, continued protection of uphill lands (wilderness and national forest) and rural fragmentation of 5 acre lots on well and septic at the urban-rural interface. Environmental considerations have generally focused on a shift upland from floodways due to increased flooding, regulations and costs.

Good density: Density was seen as an environmentally and socially positive pattern, but lacking market demand. Density is seen as conducive to supporting arts and culture, service provision, reducing land conversion and fragmentation, reducing VMTs and paved surfaces, and increasing quality of life attributes. The Growth Management Act was seen as a driver of density, though often criticized as ineffective and poorly implemented.

The Incorporated Basin: Historically, the Basin was organized around the City of Everett, with rural resource-based communities within unincorporated King and Snohomish Counties. However, over the last decade Snohomish County was the fastest growing county in the country, and the majority of the growth occurred within small incorporated cities within the Basin. Municipalities generally favor annexing commercial lands, as they bring in a larger tax revenue, while residential lands are increasingly recognized as being cost prohibitive to service. Some cities, like Duvall, Carnation and North Bend, were growing so fast they actually had to put in place moratorium to stop additional growth. The Basin's landscape today is characterized by several small to mid-sized cities (with Seattle being the closest-first tier city), often outcompeting each other for resources.

Drive till you quality: As higher income jobs moved in, so have residents, and rises in rents, making farming and timber production less affordable and increasing the conversion rate of residential land. Subsequently, land ownership has been increasingly fragmented into smaller parcels which affect management and long-term protection. Participating farmland advocates mentioned that floodplains may actually protect agricultural production by keeping real estate values low while upland parcels with good views can maintain high values even when development rights are purchased. Lastly, the recent downfall in economic downturn has shifted the Basin's significant growth trends, albeit perhaps only in the short term.

"importance"

34 ***comments***

Incorporations are an important factor.

Built out, growth and sprawl. Not a bad thing, but the #1 driver.

Credit ratings are important, what a home appraises at.

More development, influencing the shape of the floodplain.

Land use changes may encompass loss of farmland, forest loss, increased fragmentation and impervious surfaces.

There will be little progress in constraining development.

The shift in housing and job numbers has important land use and transportation implications.

The urban footprint is significantly different today compared to 50 years ago.

The accessibility of an area to the rest of the region is a vital component.

Biggest on-the-ground game changes are the broader diversity in job centers.

Geographic diversity is key.

Accommodating growth is the focus now.

We're on the cusp of major changes in housing policy.

Cost of mortgage and commute time are important.

There has been a dramatic march of suburbia north and south.

The challenge will be where to locate development so that it will not impact critical watershed processes and functions.

Privacy is huge.

"uncertainty"

40 ***comments***

We could see a move toward more compact residential development.

If the current recession is masking peak oil production, we may see increased efficiency and compact neighborhoods in the future.

We may need to slow down development and convert some back to agriculture.

There is only so much land, how much upland is available for build out?

Will the aging population stay in their houses or downsize?

How do choices of the green movement alter the housing market?

If the region is growing, Basin could be a value to where the growth could go.

Either people will live in more efficient homes or inequalities will heighten.

We have yet to see how our track record hold up with the GMA. Can we stick to it?

It is risky to base trends on today. Excluding the past two years, the trend in housing was to go larger.

Everyone recognizes that the majority of growth will happen at the periphery, the question is will it be more compact and connected with mass transit?

Increased flooding may lead to relocation out of the floodplain, easing the purchase of easements .

Perhaps in 50 years there will be more telecommuting. This may cause people to live further in the woods.

Will the GMA actually shape growth?

How will zoning and land use change?

Will we see more multi-family and condominiums?

Infrastructure's *Relevance to the Basin*

Transportation Costs: Transportation choices have environmental, economic and social costs. Environmental costs stem from the initial clearing of forests, impervious surfaces, non-point pollution, fragmentation of habitat, spread of invasive species and emissions. Economic costs are associated with funding new infrastructure, maintaining failing roads, externalizing the costs of transportation, as well as opportunity costs associated with limited infrastructure. The number one social cost discussed was traffic. 130,000 people leave Snohomish County for King County every day creating drastic congestion along the I-5 corridor.
Vehicle miles traveled (VMT), has risen faster than population rates in the Basin, indicating increasingly inefficient growth patterns.

New energy sources: Since the 1970's energy consumption has remained flat because consumption grew alongside gains in efficiencies. The 6th Power Plan assumes a continued modest growth of 0.3% energy consumption per year, even considering economic growth. However, uncertainty around peak oil production is challenging long term estimates. Sources of energy in the Basin are currently 90% fossil fuels (from hundreds of miles away) and 10% hydropower (Culback Dam). There is currently a massive push to change the sources of energy provision due to resulting emissions (climate change), biodiversity loss, and the cost of infrastructure. Participants focused their discussion on sources of energy generation (fossil fuels, hydropower, biofuels and green energy), format of distribution (centralized versus distributed) and the cost of energy.

Flood mitigation: Flood mitigation lies at the intersection of the agriculture and salmon controversy. The majority of armaments along Basin waterways were placed around the 30's and 40's by King and Snohomish Counties to protect properties from flooding. Shoreline armaments have since been linked to reduction in riparian habitat, loss of hydrological function and loss of rearing salmon habitat. In the 1990's the Shoreline Management Act ushered a flood consciousness with a resulting shift in County actions towards floodplain protection. Increasing flood frequency has exacerbated tensions between lowland properties, owners and County agencies. Furthermore, tensions arise as climate impacts are anticipated to increase the frequency and magnitude of floods.

Waste stream: Today's three main waste stream issues are carbon emissions, stormwater runoff and wastewater (sewer and septic). With increasing concerns over climate impacts, air pollution associated with energy (home electricity), car emissions, and industry pollution are likely to be under closer scrutiny of regulations. Increasing stormwater runoff is rivaling river flooding as one of the most damaging hazards to lowland properties, carrying non-point source pollution, as well as temperature and timing impacts affecting the protection of water quality. Bacterial contamination of water bodies associated with sewer and septic provision (waste water) continues to be challenge to water quality (eColi and HABs).

Will we have enoguh water? The Snohomish Basin was traditionally seen as a wet watershed with abundant water resources. The current system is largely divided by individual wells (rural) and reservoirs (supported by dams) servicing urban users. Within the Basin, the Tolt (King County) and Spada (Snohomish County) reservoirs service 80% of the population. While there is currently plenty of water in the reservoirs to service even a growing population, seasonal shortages associated with climatic changes are foreseen as a future obstacle. The decline of snowpack as temporary reservoirs coupled with lower summer precipitation may have a significant impact on summer volumes. Further, extension of services to new residential customers is very costly. When major expansion to facilities do occur (such as those in North Bend and Duvall) they usher in tremendous new growth.

"importance"

33 *comments*

When we reach peak oil production it will usher in increased efficiency.

Historically the loss of forests was due to firewood and steel production. This could return and be a big deal.

Water will be an issue in Snoqualmie. We may need to seriously look at constructing dams for flood protection and irrigation.

A shift in housing and job numbers has important land use and transportation implications.

Trade and port activity is important, especially accommodating vehicles to support the port's activities.

Water will definitely influence future growth, especially those on individual wells.

Climate impacts coupled with levees will make rivers such as the Tolt dramatically less hospitable to salmon.

There is a lot to think about with biofuels, growing trees to turn into energy.

Transportation costs and infrastructure are important in determining where people live.

By 2060 we will have hit peak oil production and associated environmental impacts will be severe.

We could see a catastrophic failure, a structural collapse of the Tolt and Culmback dams wreaking massive damages on the lower valley.

Financing any new infrastructure is extremely difficult.

Population and transportation will be key drivers.

Transportation will shape the impact and delivery of economic services.

A big game changer will be solar powered generation on roof tops.

The era of no limits is over. It is more economical to conserve than to build more.

"uncertainty"

59 *comments*

Currently exempt wells may see more regulations, no more free water.

Will we invest in new stuff or repair existing infrastructure?

What will be the future influence of oil prices?

What could allow vehicle miles to continue to decrease?

What new transportation options will arise?

Will cellulose be a viable alternative source of energy?

Biggest uncertainty is on emission and energy consumption.

What will happen to port activity with the Panama Canal expansion?

We have talked about too much water with flooding/ Could we not have enough?

Maybe in 50 years there will be no more landfills. We will recycle everything.

Maybe we will use reclaimed water from Brightwater to irrigate fields and recharge wetlands.

Rainier could erupt and destroy a lot of infrastructure.

We could see closed loop systems for water, energy and waste.

Dams might come back.

Timber may be more valued if energy costs go up.

We may see more distributed technology.

We may see more alternative energy growth, not much within the Basin other than hydro.

The extraction of shale gas may be a new important driver.

Resource Management's *Relevance to the Basin*

The farm fish debate: Farming today is not what is was 50 years ago, and for agriculture to remain in the Basin another 50 some drastic changes will need to occur. In Snohomish Basin, the largest obstacle is the 'farm fish debate', the culmination of half a dozen challenges, bringing a lot of attention to agriculture. The farm fish debate is predicated on the idea that agriculture and salmon protection are mutually exclusive, and is exacerbated by dwindling profits, urbanization, climate impacts, regulation, shifts in public perception and peak oil. While many farmers and farmland advocates argue that farming and salmon can (and even must) coexist, current solutions remain controversial.

Today's farmer: The perception and expectations from farmers and the farming community have changed. The farmer's role is much broader today, characterized as hired hand, mechanic, manager, website developer, public persona, midwife, marketer, even experts in regulatory reform and funding opportunities. Many farmers are new to the field and don't yet know what they are doing, yet they are committed to reducing their impact to the land. And in today's market consumers expect farmers to tend their market stand, apply wholistic or organic practices, be 'salmon safe' and safeguard long term food security for the urban community.

Wilderness: One mechanism to protect forests and sensitive ecosystems is to purchase them and limit their operations and management. In addition to National Parks and preserved easements (such as the Snoqualmie Tree Farm) the Basin boasts three large wilderness areas (Alpine Lakes ('76), Henry Jackson ('84) and Wild Sky ('07). These federally owned lands allow only minimal grazing, harvesting or motorized travel. While their annual usage is higher than any State parks, there is little visible human impacts. It seems their largest influences come from outside their boundaries including conflicts at the urban-interface, species migrations from climate change, and long-term regulations and managements dictated by politics.

Forest Industry: Looking back, at its peak logging accrued over 50% of the State's domestic product. Most employment was intricately linked to natural resources, and most residences could walk to a working forest. By the late 90's the timber industry collapsed, the mills were closed and large parcels subdivided and sold.Today's forests are owned by insurance companies, conservation minded recreational forests, US Forest Service and few remaining middle sized family farms (i.e. Pilchuck Tree Farm). Many of the small forest parcels are managed by owners who have a lower economic dependence on timber sales, have limited experience, or operational knowledge as foresters and have purchased the land for privacy, conservation ethic, and aesthetics. While large scale owners have in the past been blamed for habitat destruction, their larger scale, years of experience, longer-term vision and need for public credibility may lead to better practices.

The future of recreation: Participants are predicting further changes as we see more urban users, higher gas prices, technological innovations, climate change and budget cuts. For example, horse ranches, petting farms and bicycle trails are gaining popularity along the rural landscape. New watercrafts and mountain bikes are letting users into natural areas further and faster. The proximity to urban centers and increasing gas prices may shift hiking towards day or weekend uses. Websites are changing the communication of trail conditions and networks. Higher gas prices and private passes may lead towards exclusion of lower income households. Climate change may shift ski resorts towards a summer market. Lastly, cuts in agency budgets may lead to trail closures, reduced regulatory oversight, lack of maintenance, and innovative strategies to manage 'more use and less impact'.

"importance"

45 *comments*

The balance between fish habitat protection and agricultural use is a major challenge and will continue to be so.

The lack of agricultural infrastructure is one of the biggest problems.

Forests in the Basin were used as firewood for steel production. This could return and be a big deal.

There is a huge emphasis on farming now, it's coming back.

ESA listings have significantly increased resulting in substantial conservation donations from farmers.

Collectively we agree that agriculture is important. We all need to eat, we need to demand it as a priority.

There has been a striking upgrade in resource management on behalf of the Tribes.

There is a lot to think about with biofuels, growing trees into energy.

In this region, recreation is an immense natural resource opportunity.

Chuckanut Mountain is now used for recreation. It's a major shift.

Privacy is a huge thing for small forest landowners. It's a huge motivator.

The first question to ask is will it be a forest. The second is whether it will be working.

The damage to public resources resulting from the smaller manager parcels can be huge.

Local organic farmers are the fastest growing sector in agriculture. The big mover.

60,000 acres of protected agricultural lands are not high above sea level.

"uncertainty"

64 *comments*

Will the economy be restructured so we get more local productivity? Will we be forced to do that?

Maybe increased fire risk due to lack of forest management, especially with declining funding.

Soon it may be too wet to farm.

Perhaps all of Snoqualmie will be protected by 2060?

Will drain permit costs lead to the demise of farms?

Investment firms now own the majority of timber. For good or bad, it's a major shift in the pool of investors.

In the future, all local farms may be organic? Or none?

Perhaps in the future subsidies will be different.

Future of agriculture goes to intensifying production?

May need to slow down development and convert some land back to agriculture.

Will there be more support from outside our region for us to grow food for the country?

We could see synbio (synthetic biology) changing how we produce large amounts of food.

Basin becomes even more recreation focused?

Perhaps forests will be used for carbon storage, no rotation at all.

Do we need farmland for people, or do we need fish? They can coexist, but may entail litigation.

If we lose Boeing or Microsoft, we could see less people and less pressure on resources

There may be changes towards active management in wilderness areas where before it was more 'hands offs'

How do we craft regulations to meet the changing needs of farmers?

Biophysical templates'

Relevance to the basin

Rich Basin earth: The Basin's soils and minerals were described in terms of rich agricultural soil and a legacy of mines. The Basin has traditionally supported agricultural activities in its lowlands (floodplain) although recent introductions of new crops (such as grapes and ornamentals) are utilizing upland soils. In the past, the Cascades were mined for copper, gold, and silver bringing the first large economic migration into the Basin. The Basin's geology is also responsible for the support of fish and wildlife, from fish spawning to bird feeding. The thick organic horizon (duff) that once comprised the forest floor has largely been removed and replaced with impervious surfaces, exposed earth and frequently harvested monocultures. These changes have led to greater sedimentation and lower infiltration rates in lowland areas.

Seismic opportunities: The Basin lies atop the Cascadia Subduction Zone including the volcanic mountains of Ranier and Glacier Peak. The last earthquake occured 310 years ago, with a 500 year interval. Tsunamis have historically occurred along the coast. A seismic hazard event would incur major economic and human health costs. Globally, major disasters such as volcanic eruptions, can affect the region's economy via increases in industries associated with relief efforts. In the 1920's a major earthquake in Japan created a major economic boom in the shingle industry.

Nutrients and chemicals: Described Basin sources of nutrients and chemicals included nitrogen fertilization, manure waste from leaky septics and cattle manure, toxins associated with transportation corridors, and bacteria (eColi and Harmful Algal Blooms associated with fecal matter).

Landscape movement: Participants discussed salmon habitat deterioration associated with sedimentation and the loss of bedload transport as a result of agriculture and development. Lahars and avalanches were mentioned in relation to increasing recreation trends in wilderness areas and potential future climate impacts.

"importance"

5 ***comments***

Snowpack is an important to support decompositional activity.

Earthquakes and avalanches are some of the major hazards in the Basin.

There is a significant increase in water quality problems, such as increased nutrient loading and responses in the environment such as harmful algae blooms.

"uncertainty"

7 ***comments***

What about natural disasters? Earthquakes?

Natural disasters could get worse

A big one could occur, like a volcanic eruption.

Rainier could erupt or an event along the Cascadia Fault. Either would destroy lots of infrastructure.

We may be due for an earthquake in 20-30 years. This could be good or bad; an opportunity to renew aging infrastructure.

We may see a slight decline in soil and air temperature due to the reduction of insulating snow.

Soil carbon could have an inhibitory effect on decomposition if levels get too high.

Public recreation trends and avalanches may be a new big death contributor. This currently unregulated factor could shift the safety focus.

Climate's *Relevance to the Basin*

Controlling air quality: Air quality in the Basin has significantly changed over the last fifty years; in one regard there was smaller population and less traffic, on the other hand industrial pollution regulations were more permissive. The legacy of contamination includes asbestos, sulfides, diesel, and fires while more current pollution is associated NO_x and ozone. Future regulations might tighten further alongside escalating human and environmental health problems. The organic movement, the Regional Haze Rule governing air quality standards, and technological innovations may affect air quality, all with significant economic implications for the Basin.

Carbon counts: Development patterns and energy consumption are the leading contributors to fluxes in the carbon cycle. Carbon storage is largely associated with forest stands and marine vegetation. Future fluxes and storage are largely uncertain including factors such as validation of climate models, potential efficacy of regulations, and incentives (trade and cap), and energy technologies (wood burning stove or green energy). Carbon enrichment may have significant implications to ecosystem health influencing forest stocks (growth stocks currently 40% beyond expected model curves), and decomposition rates (influenced by soil carbon).

When will the fall rains start? Changes stem from a shift in the annual precipitation, seasonality (timing) and severity of storms. By 2080, the Region is projected to increase by 1-2% with increaes in precipitation fluctuations and extreme events. Precipitation changes has implications on vegetation patterns, water storage, stream vegetation and fire. There is a lot of uncertainty associated with future predictions of precipitation patterns, influence of transient watershed zone and changes in snowpack, and implications on ecosystem and infrastructure services (i.e. resilience, flooding, pests, water availability).

Melting snow pack: Temperature increases are influencing mid-elevation basins due to changes in melt timing and accumulation of snowpack. This has a significant implication on seasonal stream flows, water storage, recreation and vegetation. Transient (snow-rain, mid-elevation) watersheds, such as the Snoqualmie, are more sensitive to temperature changes as warmer temperatures will shift them from being snow- to rainfall-dominant. This will result in larger, faster winter flows and lower base flows and drought in the summer. The cumulative impact (water quality impairments due to temperature and flow changes) will have significant impacts on stream habitat and salmon. Runoff timing will also put us at higher risk for flooding (especially streamside residents and infrastructure). As our glaciers recede we will experience lower summer water availability as we currently rely on snowmelt for water supply. This will increase our reliance on reservoirs and groundwater.

Rising temperature: Current models project 3degF increase by 2040 and 5.3degF increase by the 2080's. We are likely to see warmer winters, a shift in seasonal timing and warmer stream temperatures. Warmer temperatures will likely lead to increase infrastructure pressure, including higher energy consumption and lower water storage. Water temperatures will also influence water quality, with implications for anadromous fish and other aquatic organisms. Exceedance of thermal envelopes is especially relevant as human landscape alterations already increase temperatures via development, extraction, pollution. Furthermore, shift from snowpack- to rain-dominant watersheds will reduce summer flows exacerbating temperature increases. Hazards are likely to coincide with extreme temperature events (rather than average annual increase) including floods, fire, pests, human disease.

Global climate change: Global climatic changes may impact the Basin indirectly. The most significant implications may be climate change refugees, global unrest and agricultural value associated with changes in global food scarcity.

"importance"

19 ***comments***

Climate change may be more influential in the future, it hasn't really driven much yet.

Rising rivers, meandering channels and more flooding – these will all play a huge role in where people live and what they think is important for their quality of life.

Water is the most important greenhouse gas, accounting for 90% of the effect. It effectively swamps out anthropogenic carbon impacts.

Given levees and climate impacts, rivers like the Tolt will be even more inhospitable to fish.

Some systems will see a transition from a snowmelt to a rainfall dominated watershed.

Air quality standards affect all sectors of the economy

Global climate change issues will become more of dominant impact in how we live.

Climate change in the next 60 years could be pretty dramatic.

Looking at climate change and the concentration of people, there will be an intensification of impacts associated with hazards.

"uncertainty"

44 ***comments***

Climate change is the wildcard that magnifies our impacts on biodiversity and what we can get out of biodiversity via ecosystem services.

Was it cleaner with lower populations of commuters and roads?

What will be the responses of plant communities to extreme temperature changes?

We have been emitting high levels of carbon, but the impacts are still yet to be understood.

Climate change may be more influential than it has been

There is a lot of uncertainty about near- and long-term affects and our choices to adapt.

Maybe we get wetter. Not enough water may be an issue.

Recovery efforts for Puget Sound may not be effective. Especially when adding climate change into the mix.

Silver Firs have been expanding their range downward, which may be due to climate changes.

The big question every year is: when will the fall rains start?

We may see a shift in stream peak flow in fall-summer months.

We may see more forest insects as climate impacts may change life cycles.

How will climate impacts affect fish and wildlife?

How do we integrate climate into national policy?

Dams might come back due to climate impacts. So far the DOE has said no, but what if we did allow it?

Previously estuaries could march upstream with sea level rise, now there are dams and dikes that may limit upstream migration.

Will we have a robust trade and cap system in place?

Hydrology's *Relevance to the Basin*

More flooding: Flooding is considered to be one of the largest challenges to the built environment (in terms of development, natural resources and infrastructure) in the Basin. Participants seemed pretty sure the future will bring more flooding due to climate change, upland stormwater runoff, alterations to the rivers' morphology and loss of infiltration. Floods impact industry, houses, agriculture and fish. In terms of agriculture while flooding created the rich fertile soil that has allowed farming, it now leads to costly infrastructure repairs, changes in practices, selection of crops, and timing.

Don't contaminate our groundwater: Groundwater aquifers serve as longer term storage for drinking water. As our demands increase (more population) and storage capacity decreases (melting snowpack, quicker flows, lower infiltration) the pressure on our groundwater will increase. In order to protect groundwater, we must change our behavior to reduce contamination, especially as groundwater is more difficult to clean up, and can determine subsurface flows and water quality.

Rapid streamflows: Changes are largely associated with 1) hydrologic maturity of the Basin, 2) loss of forest duff layer, 3) increase in impervious surface and 4) climate change (change in timing of precipitation and snow melt associated with temperature increase). A shift in the hydrograph will influence water supply (all water in winter, larger need for reservoirs, flooding, scouring, salmon habitat, high temperatures, more pollutants and altering passage through dry streams).

Altered morphology: Channel migration zones are the areas adjacent to the river into which the river can move into, or flood. These zones serve as important habitat and water filtration areas. In the Basin, the rivers' morphology has been dramatically altered via industry (dredging and removal of trees), flood mitigation (levees and dams) and increase in bedload transport (development). Our understanding of the importance of these zones is still limited.

A functional watershed: The Basin we see today is a shadow of the functional watershed found a century ago. The Basin has seen drastic change from industries, agricultural and timber production, diking of the delta, filling the wetlands, development of the lowlands, and most recently climate impacts leading to warmer, faster, more acidic and earlier flows. Accordingly, our connection to and perception of the Basin has changed, from industrial backyard to personal recreation and sanctuary.

Water quality: Water quality varies due to natural processes (rain, soil ,biology) however extreme variation is not natural. Water quality has been characterized in the Basin in terms of pH, dissolved oxygen, turbidity and scour, temperature, bacteria (fecal coliform, manure), nutrients (phosphorous and nitrogen), and toxins (arsenic, HABs). Temperature increases, a consequence of urbanization (extracting, stripping, developing, consuming), was the most frequently referred to water quality impairment. Climate change is predicted to further challenge water quality levels. Regulation around water quality initiated with the Clean Water Act (1972) has continued to strengthen towards a systems-approach integrating the management or protection of riparian areas, streamflows, infiltration, groundwater, and storage.

Water conservation: The Pacific Northwest is seen as a water 'rich' Basin. Prior to 1960's conservation (of water supply) wasn't thought about. This abundance has shaped the Basin in terms of industry and population migration as well as our behavior. In the future, we may see shortages due to changes in 1) population (more people, higher consumption), 2) climate change (lower summer flows, loss of snowpack 'reservoirs') and 3) land cover change (loss of storage) with the potential for 4) loss due to contamination (of groundwater).

"importance"

15 ***comments***

The health of the water in Puget Sound will drive future regulations

Development will influence the shape of the floodplain

Water quality has become more of a problem on the Snoqualmie and its tributaries

The Snohomish Basin is of critical importance as the 4 rivers here determine policies for the rest of the State.

Rising rivers, meandering channels and flooding impacts will play a huge role in where people live and what they think is important for their quality of life.

Change in forest land cover has had impacts on water quality and quantity and all the other ecosystem services provided by intact forests

Flooding is a major hazard in the Basin.

In 50 years, flooding will certainly be an issue, it has been since settlement times.

There is a significant increase in water quality problems.

The challenge will be where to locate development so that it will not impact critical watershed processes and functions.

The first goal, the limiting factor is getting the delta back. And to do that, we need to slow down our rivers.

"uncertainty"

15 ***comments***

Soon it may be too wet to farm

Climate change, dams, food security and flooding – what if we don't have enough water?

Natural disasters could get worse.

We may see a shift in stream peak flow in the fall-winter months. We may see warming rivers and repeated exceedance of temperature thresholds impacts anadromous fish.

We could see increased summer drought stress

Flooding and relocation out of the floodplain may ease purchase of development easements, increase protection of natural areas for reduced risk and greater public access to open space

Even if our restoration efforts succeed in getting the land back to the streams and rivers, the water may be too acidic and early.

There is uncertainty with salmon recovery.

Terrestrial Biosphere's *Relevance to the Basin*

Understanding biodiversity: Biodiversity provides ecosystem services such as provision of food, fuel and fiber, control of pests and diseases, cultural and aesthetic benefits, and genetic resources. Regulations such as the Endangered Species Act are specifically targeted to mitigate human impacts. In the Snohomish Basin, both the Spotted Owl controversy and salmon listing, associated with the ESA, have had direct implications on agriculture, timber and cultural perceptions. Future impacts of climate change, increasing population growth and lag times associated with past change are believed to magnify future threats to biodiversity.

Sea Level Rise and Estuaries: The Snohomish Estuary is still relatively intact and features 40 miles of slough channels, nine upstream miles of tidal influence and a protected upper watershed, all within proximity to a major urban core; a truly unique amenity. However the potential to protect and restore the delta relies heavily in our ability to slow down our rivers and the sediment associated with first and second order streams. A major future uncertainty lies in the implications of sea level rise and the associated salinity plumes on salmon, especially when confounded by dikes limiting upland migrations.

Fire risks: While outside the fire zone, the Basin has experienced several major fires in the past including a massive wet coniferous 'crown fire' (last one in 1701) and lightening fires on a 100-200 year return interval. Potential increases in risks are associated with changes in precipitation, temperature and deforestation. A Basin fire would have significant sociopolitical implications, especially to smaller rural communities. However, the West side is in good shape in terms of resilience from fire' due to higher elevations (drought tolerant) species, active management (private lands), wind migrations (east to west is rare) and moisture.

Forest habitat: While much of the Basin was logged a century ago, current aerial photos show more vegetation now than in 1950 as the forest is re-growing. Challenges today include continued fragmentation due to residential development and management practices (harvest rotations and monoculture stands). Many experts are also seeing shifts associated with climate change variables leading to species migrations and increase in biomass accumulation. There is disagreement among experts on the implications of ownership (private vs. public), recreation, and resilience. The future outlook among experts is largely positive, due to protection measures in place and supportive public awareness and engagement.

The spread of invasives: Over the last two decades the Basin has experienced a massive increase in weeds associated with fragmentation and loss of native habitat, transportation corridors (traffic, wheel dump) and time. Insects and diseases are correlated to plant susceptibility (sometimes attacking weaker plants while at times attacking more vigorous specimens).

Salmon and streams: The Snohomish Basin is home to 2 Chinook populations and steelhead. Salmon have important cultural and economic values; they also function as indicators of watershed health. The Basin's streams are home to migrating salmon and are critical to their survival, alongside other ecosystem services such as drinking water, recreation, habitat for a bio-diverse community of plants and animals, and Tribal livelihood. Basin streams are described as 'unraveling' both physically and biologically; no longer as productive or with the same species richness. The salmon decline has been huge and according to some groups, our current assessment of decline may still be orders of magnitude off. The major restoration objectives are to reestablish riparian habitat and large woody debris, reduce winter scour, slow down the river, raise summer base flow, and to cool water temperature.

"importance"

16 ***comments***

The salmon decline is huge, the efforts mandated by the ESA. That is a big difference between then and now, because our resources weren't as stressed.

This denial of historical resources is a major driver for losing our wetlands and tributaries.

The balance between fish habitat protection and agricultural use is a major challenge and will continue to be so.

Given levees and climate change, rivers like the Tolt will be even more inhospitable to fish – perhaps dramatically so.

In 50 years habitat could be completely devastated from invasive weeds.

Huge explosion of invasive species, especially in the last 15-20 years.

CO_2 enrichment, an unexpected dramatic change from 40 years ago is the growth rate of young National Forest stands. Forest growth is off the chart!

Digital data will be even more important in the future, depicting boundaries of critical areas.

The limiting factor is getting the delta back.

Fish and culture are important things that lead to joint decision making for salmon.

The underpinning for a new look: how do we get society to keep the forest forested?

"uncertainty"

44 ***comments***

What are the thresholds for biodiversity?

What will be the responses of plant communities to extreme temperature changes?

Due to burn policies or lack of forest management maybe increased fire risk?

If management practices actually succeed in benefitting salmon will it only lead to bigger buffers?

How resilient is the ecosystem?

Climate change is the wildcard that magnifies our impacts on biodiversity.

Insects and diseases are related to plant susceptibility, sometimes they attack vigorous plants, sometimes weaker specimens, it is unique to the disease.

Given levees and the likely impacts of climate change, rivers like the Tolt will be even more inhospitable to fish – perhaps dramatically so.

Will the ESA standards be lowered? Will there be additional listings?

How skewed is our understanding of historical Steelhead populations?

How often will we exceed temperature thresholds?

Snohomish estuary could be much more restored along some of the major rivers.

There is the fish vs. agriculture conflict: do we need farmland for people or do we need fish?

The Whitebark Pine may be designated as an endangered species.

There is uncertainty with salmon recovery.

The question is how do we accommodated growth while maintaining habitat.

Scenario Logics Workshop

Date

6.9.2010

Location

Graham Visitor's Center. Seattle, WA

Objective

One day workshop to develop Scenario Logics for the Snohomish Basin. Specifically select most important and uncertain driving forces and identify hypotheses for alternative futures including potential threats and opportunities.

Attendance

26 members of the Science Team.

Agenda

- Presentation on scenario planning approach and synthesis of project progress.
- Team exercise: teams test out hypotheses by intersecting the two most critical and uncertain driving forces.
- Discussion: Participants discuss prioritization of driving forces with the goal of developing divergen scenarios. Participants vote on key drivers.
- Team exercise 2. Teams develop final logics based on selected key drivers. Teams establish alternative hypotheses and discuss tradeoffs across scenarios.
- Discussion: participants evalute alternative scenarios.

Materials

(see presentation slides pages A6.89-97)

Scenario Logics Workshop

June 9th 2011

Thank you for coming!

- Abbott, Norm
- Babby, Elaine
- Bartz, Krista
- Beyers, Bill
- Bilby, Bob
- Bolotin, Leah
- Bostrom, Ann
- Bylin, Ann
- Crane, Paul Byron
- Gamon, John
- Geerlofs, Simon
- Hamlet, Alan
- Heintz, Kelly
- Hook, Abby
- Jerabek, Jennifer
- Kaje, Janne
- Kelly, Alice
- Klug, Jacque
- Lackey, Brent
- Leschine, Tom
- March, Mike
- McGuire, Al
- Meyers, Phyllis
- Moore, Scott
- Powell, Scott
- Rawson, Kit
- Rustay, Michael
- Schmidt , Rowan
- Snover, Amy
- Teverbaugh, Jim
- Tonnes, Dan
- Vernez Moudon, Anne
- Walls, Tim
- Whittington, Jan

UERL Team

Marina Alberti
Blake Trask
Michal Russo
Karis Puruncajas
Elisabeth Larson

Scenarios for Snohomish Basin 2060

Develop an assessment of key ecosystem services in the Snohomish Basin by characterizing the uncertainty associated with alternative future baseline conditions.

a 2-year research agenda
Funded by the Bullitt Foundation

Project TIMELINE

2010	Winter	*Urban Planning Class*
	Spring	Kickoff
	Summer	*Interviews*
	Fall	Conceptual Model Workshop
2011	Winter	*Basin Assessment*
	Spring	Scenario Logics Workshop
	Summer	Integrated Model Workshop
	Fall	Policy Workshop

Workshop objective

Identify alternative hypotheses (storylines) for future conditions in the Basin by exploring possible interactions among key drivers of change and their implications on future conditions.

Agenda

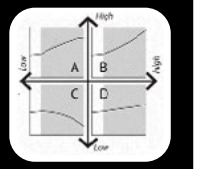
- Presentation by Marina Alberti
- Step 1 Driver Exploration
- Team Presentations
- Step 2 Discussion + Driver Selection
- **Lunch Break**
- Step 3 Scenario Logics
- Discussion + Next Steps

Project approach

Why scenario planning

Project approach

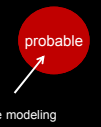
Instead of focusing on a single trajectory or prediction, we use Scenario Planning to explore alternative plausible futures and highlight the risks and opportunities involved in strategic decisions for the basin development.



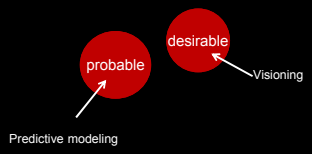
What are Scenarios

- Scenarios are **hypotheses** of alternative futures that highlight the ***risks*** and ***opportunities***.
- Scenarios focus on interactions among uncertain drivers and **expand the assumptions** of predictive models.
- Scenarios direct our attention towards the most **relevant uncertainty dimensions**.
- Scenarios ask: How robust are alternative strategies under plausible future conditions

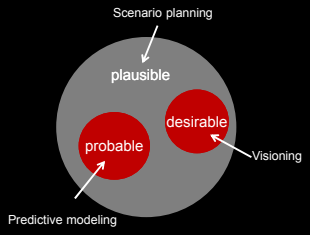
Alternative Future Approaches



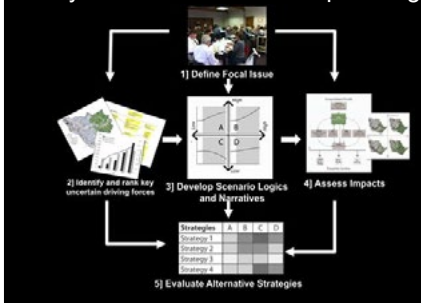
Alternative Future Approaches



Alternative Future Approaches



Key elements of scenario planning



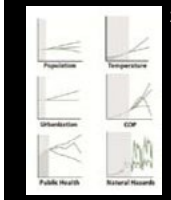
Key elements of scenario planning

1. **Define focal issue**
   - Data and observations
   - Historical documents
   - Expert knowledge
   - Conceptual models

↓ **OBJECTIVE:**

Develop a shared problem definition

Key elements of scenario planning

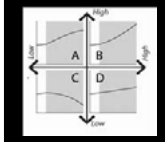


2. **Identify and rank driving forces**
   - Identify key driving force
   - Rank their importance
   - Rank their uncertainty
   - Select most important & uncertain

↓ **OBJECTIVE:**

To capture the most divergent yet plausible futures

Key elements of scenario planning



3. **Develop scenario logics and narratives**
   - Selected driving forces create the frames for scenario logics
   - Participants develop the story lines and narratives

↓ **OBJECTIVE:**

Four distinct stories of how the future can unfold

Key elements of scenario planning

4. Assess Impacts

- Identify indicators
- Apply predictive models
- Assess impact of future conditions

↓ **OBJECTIVE:**

An assessment of future conditions

Key elements of scenario planning

5. Evaluate alternative strategies

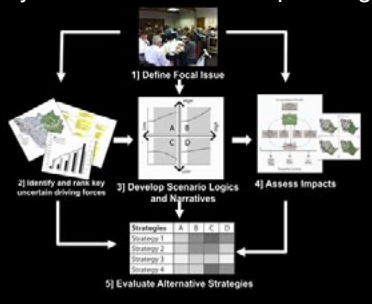
Strategies	A	B	C	D
Strategy 1				
Strategy 2				
Strategy 3				
Strategy 4				

- Use indicators to evaluate alternative strategies (their efficacy and robustness) under alternative scenarios.

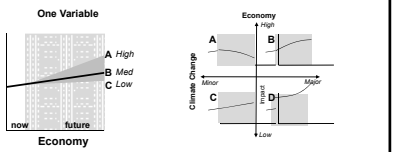
↓ **OBJECTIVE:**

An evaluation of alternative strategies

Key elements of scenario planning



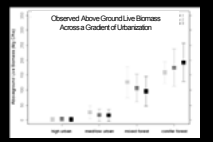
Predictions vs. Scenarios



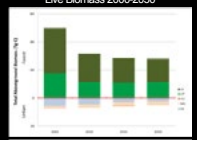
Predictive Models

Predicting Carbon Stocks in Central Puget Sound

Land Cover Change 2000-2050

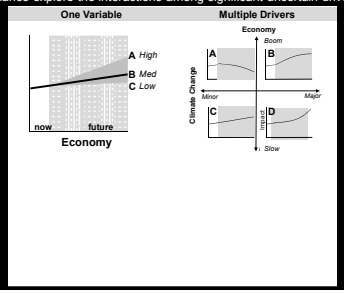


Live Biomass 2000-2050



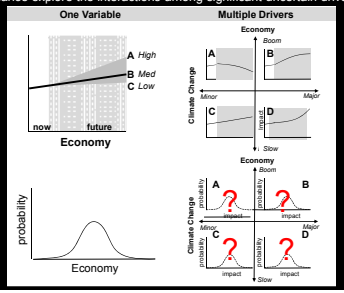
Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers



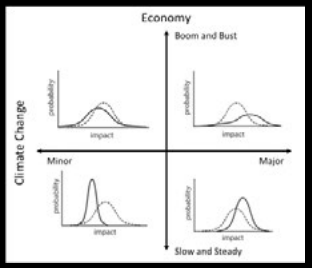
Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers

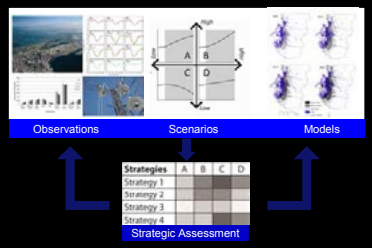


Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers



Linking Observations, Scenarios, and Models



Synthesis

What we heard from you

Rationale behind scenario logics

In order to develop scenarios that take into the most divergent plausible futures, we must explore interactions among critical and uncertain driving forces which may challenge our assumptions about future trajectories.

Your input

- Formulate questions and frame the problem from different perspectives
- Identify driving forces and develop shared definitions
- Explore past, current and future trajectories of the selected driving forces
- Explore similarities and differences in how experts view relationships, uncertainty, and importance of different driving forces

Teams and Activities

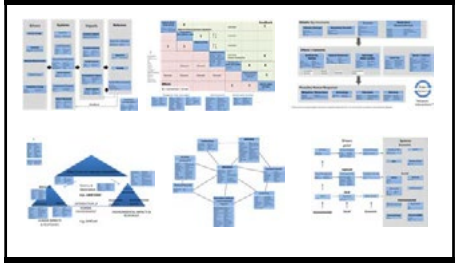
- Steering Committee
- Science Team
- Expert Interviews
- Conceptual Model workshop
- Synthesis

Keywords

60+ stories about the Basin's past and future

Example: Change in industry

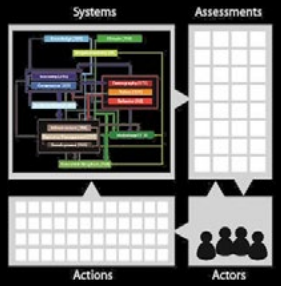
Team Conceptual Models



Workshop Directives

- **Clarity:** Clear purpose, well communicated, transparent
- **Parsimony:** Balance complexity and simplicity
- **Multiple scales:** Be relevant at local and regional scale.
- **Actors:** Representing stakeholders and decision makers
- **Dynamic:** Show feedbacks and interdependences.
- **Validation:** Claims should be validated
- **Impacts:** Depict strong, multiple relationships.
- **Highlight uncertainty:** Incorporate risks and resilience.
- **Link to measurements:** Indicators and metrics.
- **Decision making:** Reflect who are the decision makers.
- **Time:** Legacies and baselines inform future condition.
- **Organization:** Organize by environmental, social and economic groups

Shared Conceptual Model



Synthesis

Code keywords for driving forces

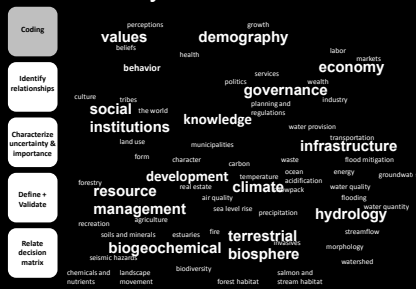
Identify relationships

Characterize uncertainty and importance

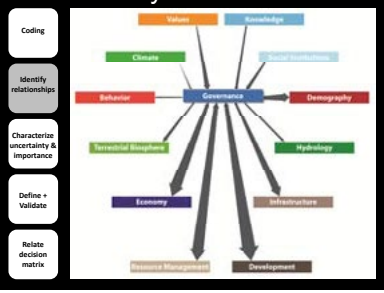
Define and validate drivers

Relate decision matrix

Synthesis



Synthesis



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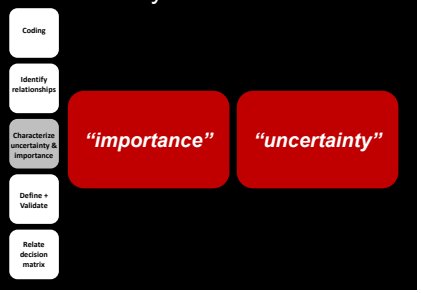
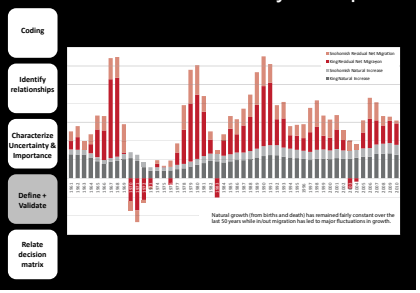
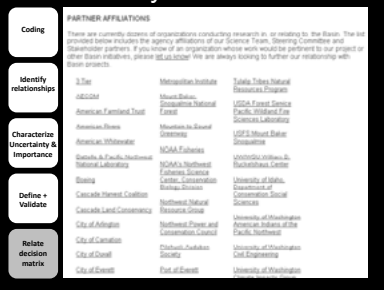


What have we done with your input



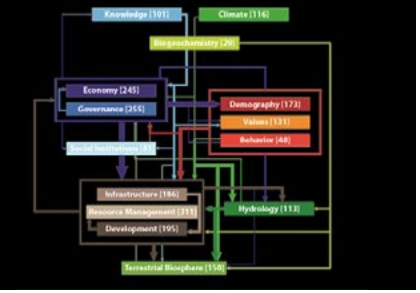
Synthesis



State of the Basin Assessment

Selection of drivers, their relationship and characterization

Conceptual model: *Systems network*



Human Drivers

Demography | Behavior | Values

90,000 people
diversity
aging

consumption

environment

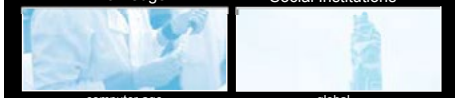
Institutional Drivers

Economy | Governance

resource to service

heavy regulation

Knowledge | Social Institutions



computer age

global

Built Environment Drivers

Development | Infrastructure | Resource Management

sprawl

abundance to conservation

smaller scale

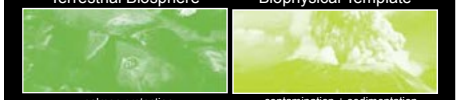
Natural Environment Drivers

Hydrology | Climate

changed timing and volume

got on the agenda

Terrestrial Biosphere | Biophysical Template



salmon protection

contamination + sedimentation

Scenario Logic Exercise

introduction

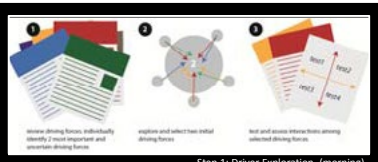
Scenario logics objectives

- **Objective for Today:** Identify alternative hypotheses (storylines) for future conditions in the Basin by exploring possible interactions among key drivers of change and their implications on future conditions.

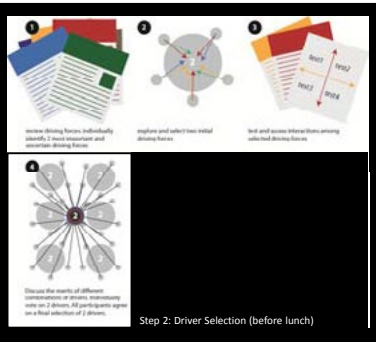
  Step 1 Driver Exploration *(Morning)*: Explore and assess importance and uncertainty of various driving forces by testing initial selection and postulating alternative hypotheses from their interactions (Individually and by teams).

  Step 2 Driver Selection *(Lunch)*: Select final key driving forces which will guide the development of the story lines (All).

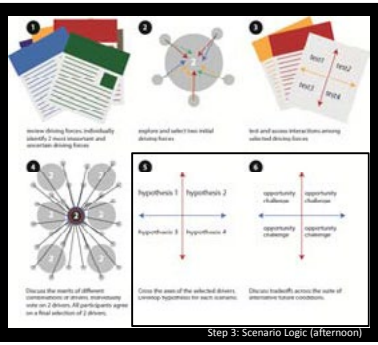
  Step 3 Scenario Logics (*Afternoon*): Develop scenario hypotheses and highlight tradeoffs by identifying opportunities and challenges.



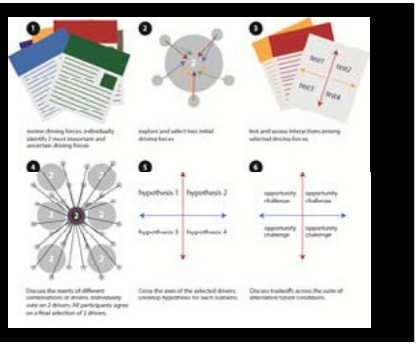
Step 1: Driver Exploration (morning)



Step 2: Driver Selection (before lunch)



Step 3: Scenario Logic (afternoon)



Importance and Uncertainty

- **Importance:** The magnitude of impact on the focal issue.
  - *For example, precipitation and impervious surfaces are important drivers in streamflow.*
- **Uncertainty:** The magnitude and direction of a trend is unknown or accurately predictable
  - *For example: The Region could become the next biotech center, or Boeing could leave the Basin.*

Step 1 Driver Exploration

instructions

Instructions

- Look over the driving forces working documents and choose the 2 most **critical and uncertain drivers**.
- Discuss selection and **finalize 2** per table.
- Test selected drivers and their interactions in relation to the focal issue.
- Select a **variable** and 2 **end-state** conditions per driver.
- Discuss selected drivers against other alternative choices.

Roles

- Moderator
- Note taker
- Timekeeper
- Illustrator
- Presenter

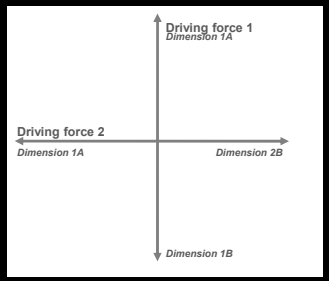
What's on your table

- Instructions packet
- Driving forces working documents
- Scenario logics board
- Voting ballots (index cards)

Driving Force Working Document

- **Objective:** To help make an informed decision in selecting the most important and uncertain driving forces.
- **Contents:**
  - Definitions
  - Published Data (graphs and maps)
  - Science Team Synthesis
    - Relevance to the Basin
    - Importance and Uncertainty
    - Relationship to other driving forces

Your logics should look like this



Step 1 Driver Exploration

Review drivers
Select 2 drivers
Cross axes
Identify variables and end states
Discuss hypotheses and driver interactions
Discuss assumptions challenged

Presentations

What assumptions did your team challenge?
State your two drivers and variables

Discussion

Selecting the most important and uncertain driving forces

Discussion Questions

- What are critical uncertainties of the selected driving forces?
- How do they affect the focal issue?
- What are some hypotheses about future interactions?
- How do these hypotheses challenge the assumptions we make about the future?
- What are some alternative hypotheses about what drives the future?

Step 2 Driver Selection

Discuss implications of alterative driving forces
Vote on final set of drivers

Importance and Uncertainty

- In order to identify the most divergent scenarios, scenario planning requires that we identify the most important and uncertain driving forces.
- Important because they have an effect on the focal issue (whether direct or indirect)
- Uncertain because we cannot accurately predict the occurrence of future conditions.
- Uncertainty also relates to controllability. We generally look for drivers that we (as stakeholders and decision makers) cannot directly control.

Plausible not Probable

- The role of the Scenario Logics is to identify alternative plausible scenarios that takes into account irreducible uncertainties. It is not to accurately predict future conditions.
- Our aim is to characterize the most **divergent** (different) hypotheses.

Divergence and Robustness

- The objective of scenario planning is to inform decision making towards robust strategies that are effective across various plausible future conditions.
- By identifying the most divergent scenarios we aim to ensure that strategies are rigorously tested against potential future challenges.
- Scenario planning aims to identify most robust strategies (that will be effective across a range of plausible futures) as opposite to optimal solution (that will work under a probable one).

Additional objectives of Scenario Logics

- **Relevant:** in relation to the focal issue
- **Compelling:** suite of storylines, not comprehensive
- **Valid:** based on empirically based information and arguments, not opinions.

Discussion

Which two drivers are the most important and uncertain?

Step 3: Scenario Logics

Cross selected drivers
Select variables and end states
Develop hypotheses
Characterize trajectories
Discuss opportunities and challenges
Articulate tradeoffs

Instructions

- Draw logics on board including selected drivers
- Decide on variable and end state conditions for each driver
- Develop hypothesis for each frame based on the interaction of the two end state conditions.
- Characterize each scenario with three keywords
- Identify a potential opportunity and challenge for each scenario
- Articulate tradeoffs across the 4 scenarios

Step 3: Scenario Logics

Cross selected drivers
Select variables and end states
Develop hypotheses
Characterize trajectories
Discuss opportunities and challenges
Articulate tradeoffs

Discussion

Scenario Evaluation

How do we evaluate the Scenarios?

- Relevance
- Divergence
- Tradeoffs
- Compelling

Discussion

How might the scenarios challenge the assumptions of the GMA? Of restoration investments?

Dicussion

Did any of the challenges or opportunities surprise you?

Next steps

- Identify core Science Team with expertise in selected drivers.
- Refine logics and hypotheses.
- Work with predictive model team to identify forecasts and indicators of ecosystem services.

Moving forward

What would you like to see?

Synthesis

Workshop synthesis is organized around the 3 major steps of the meeting:

- Step 1: Driver Exploration,
- Step 2: Driver Selection
- and Step 3: Scenario Logics.

Step 1: Driver Exploration

Participants were asked to review a set of 14 working documents (see synthesis of Conceptual Model Workshop - pages A6.42-63)

Participants selected the two most important and uncertain driving forces, first individually and then as a table. Participants then selected a variable and set of end-states for each driver and crossed their axes to create four frames. Lastly, each table discussed potential storylines associated with each frame.

Discussion: Which drivers are more uncertain or critical?

Participants discussed the need for drivers to be both critical and uncertain. Some drivers were important and less uncertain, while others were uncertain while less important. Infrastructure, social institutions and governance were seen as relatively predictable over a 50-year time horizon. Knowledge and hydrology were seen as highly uncertain.

Participants discussed how drivers are also driven, which creates a circular argument of what drives what. This is un-resolvable in the hierarchical structure. However, some drivers have a stronger role associated with their impact as opposed to their feedback in terms of the Basin and 50 year time frame. For example, demography and ecosystems (terrestrial biosphere) were discussed as following other drivers and being more predictable. Economy, on the hand, was said to drive both values and governance, and incorporate uncertain structural change.

The other major topic of discussion was control; drivers that are outside local control, such as climate, were at first discussed as being less relevant to explore. However, scenario planning specifically focuses on drivers outside of decision maker's control, as those drivers that are controlled serve more as strategic decisions than characterizing future uncertainty.

Variable Selection: Each table selected two drivers, and then defined a variable and endpoints for each driver (see table A6.2)

Table A6.2 Step 1 Driver and Variable Team Selections

Driver	Variable	End-states
Behavior	Human-Environment interaction	no / yes
Demographics	Population well-being	low / high
Values	Perception	Common good / individualism
Values	Individual resource consumption	low / high
Economy	Adaptable market place	more / less
Economy	Wealth	high / low
Social Institutions	Culture	Sustainability / consumption
Development	Form	Sprawling / Compact
Climate	Rain / Snow	more / less
Climate	Change	global / no
Climate	Change	major / minor
Terrestrial Biosphere	Ecosystem health	full complement of species / impaired

Discussion: Implications of driver selection

Participants discussed the implications of selected drivers and associated end-states.

Correlation: some pairings of drivers are more heavily correlated than other. For example, development was said to be correlated with resource management, and climate correlated with hydrology. Looking across the four groupings of human, institutions, built environment and natural environment we looked at the pairings identified by the 6 teams (table 2). It is important to consider how the selection today may be the result of our limited knowledge base and the representation at the workshop.

Scales of influence: Spatial scale is important to consider as having different impacts. For example, what is more relevant to assess, global economic growth or regional shift in industries? Or global climate change versus local precipitation change?

Defining values: Where does the subjective bias lie in defining 'what is good'?

Outcomes vs. drivers: outcomes are the effects that occur given a set of drivers. Participants discussed how certain outcomes may lead to subsequent change, i.e. drive future conditions. For example, ecosystems are an important driver and also an outcome, prompting us to respond. Perhaps development is an outcome and not a driver? Whether something is a driver or an outcome can only be answered in relationship to the focal issue, including the scale of analysis.

STEP 2 DRIVER SELECTION go to step 3

Each team presented their initial driver selection and draft storylines. Participants discussed criteria to consider when selecting the two drivers. Individuals voted before going to lunch. After lunch, workshop participants discussed the final selection and agreed to move forward with the selection.

Participants overwhelmingly selected climate and values as the two most important and uncertain drivers (see table A6.3). The selection of values (beliefs, or intentions of actions) as opposed to behavior (actions) was challenged. On one hand, behavior is more directly related to on-the-ground changes. On the other hand, values have larger influence over multiple variables in the long term. Further, small changes in the collective cultural values can really shift the direction of investments and governance.

Table A6.3 Step 2 Driver Selection

Driver	Votes
Demographics	4
Behavior	5
Values	11
Economy	6
Governance	
Social Institutions	2
Knowledge	
Development	4
Infrastructure	
Resource Management	
Hydrology	1
Climate	12
Terrestrial Biosphere	5
Biophysical Template	

STEP 3 DRIVER SELECTION

Each team started with the two selected drivers, climate and values, and then defined a variable and two end-states for each driver. Based on these drivers and variables, each team developed storylines for four scenarios including an initial hypothesis, characterized trajectories and tradeoffs associated with opportunities and challenges. Lastly, participants joined to share their storylines and discuss how they have challenged current assumptions about future conditions.

Variable and end-state selection

Human Values: Each team characterized values in slightly different ways. The 3 common threads were:

- Individualism vs. collectivism (i.e. public good, common good, communal). A sub topic of this was willingness and responsibility; to sacrifice as an individual, to take personal responsibility and action vs. to sacrifice as a group with the potential to rely on others and exhibit individual complacency.

- Consumption vs. conservation (i.e. sustainability). A sub topic of this was environmental indifference vs. ecosystem protection. Values in relation to the environment could remain static or improve. Our acceptance of different environmental conditions could change (low vs. high quality).

- Short term and selfish vs. long term and egalitarian. A sub topic of this was how (where) we choose to invest as well as whether we adapt or postpone changing.

Climate Change: Teams seemed to be challenged by selecting only on variable of climate change and spent considerable time debating how to incorporate myriad changes in one keyword or phrase. The 4 common threads were:

- Snowpack (decreasing relative to historic records vs. stable.. Snowpack was selected for integrating both variables of precipitation and temperature as well as taking into account the challenge of water storage. Other related variables include: water supply (plentiful vs. none), precipitation (high vs. low), timing of precipitation (rain vs. snow) and temperature.

- Variability (high, major, extreme or severe vs. low, minor, mild and moderate.). A sub topic was the stability of the system.

- Streamflow or flooding (high flow vs. low flow)

- Global vs. local impacts

Initial hypotheses

Each team developed four hypotheses based on the drivers and their selected variables. While each hypothesis was unique, some overarching themes did emerge (see table A6.4). The interaction of each variable produced different storylines, however due to the limited team time end-states superficially interacted as major and minor climate impacts and same (consumptive, short term) values vs. more conservation minded (long term and collective) values. Areas of agreement between teams are included below. Areas of potential disagreement include: migrations (in which scenario are they high / low), investment decisions (i.e. mitigation vs. engineered solutions), and willingness to act (individually or collectively).

Table A6.4 Step 3 Scenario Logics Common Hypotheses

"same values" and "major climate impacts" Worst case scenario. High pressure and impacts. Consumption is high and resilience is low. Ecosystem services: degraded Details: more jobs, resource dwindled, development sprawling, less personal sacrifice, more competition and conflict	**"conservation values" and "major climate impacts"** Adaptation or challenge scenario. Pressure is met with opportunity for improvement. Ecosystem services: ? Details: increased environmental regulation, sustainable development and innovation, higher assessments and monitoring, clear mandate, reallocation of resources, collaboration.
"same values" and "minor climate impacts" Business as usual scenario. Normal, boring, medium levels. Consumption is high. Ecosystem services: fair Details: non-climate problems rise in priority, complacency.	**"conservation values" and "minor climate impacts"** Best case scenario. Pressure is low and social action is highest. Social and environmental problems are low. Ecosystem services: improved Details: shared responsibility, opportunity to fix non-climate issues, greater success, healthy, no water shortage, more time.

Trajectories

Teams discussed implications of storylines on the trajectories of other driving forces. These discussions pose important correlations to consider when developing the final scenarios in terms of both assumptions to test and specific variables to consider as indicators of change.

- Behavior: Adaptation vs. reactive, postponing change or mitigation.
- Demographics: Migration (including a mobile population) and health (including well being and early childhood experiences).
- Economy: Spatial scale (local vs. global), cost of solutions, wealth (lower vs. higher), physical size relative to biosphere, and rigid vs. adaptable.
- Governance: Alternative government and policies, tight vs. loose environmental regulations and healthcare costs.
- Social institutions: Polarized society and disparity.
- Knowledge: innovation
- Development: Pressure, form (sprawling vs compact or sustainable) and housing.
- Infrastructure: Engineered solutions, more or less extensive network, energy solutions (sustainable), levees break vs. a stepped back, more money in transportation and more driving
- Resource management: Levels of resource protection, resource exploitation, loss of agriculture (due to salmon) vs. locally grown, funded, and sustainably produced agriculture.
- Terrestrial biosphere (ecosystems): Biodiversity, carbon levels and salmon condition (none vs. healthy).
- Hydrology: Frequency and magnitude of flows (and floods) and water supply vs. shortages.

Potential opportunities and challenges

Teams finished their discussions with a look at potential opportunities and challenges associated with the different scenarios. Even a seemingly negative scenario may have potential opportunities in relationship to the focal issue, and conversely, what may at first seem like major opportunities may lead to unintended consequences.

Investment choices
Innovative funding mechanisms vs. less capital
Economic growth vs. lower environment pressure
Pressure to conserve vs. complacency
Incentives to adapt behavior
Move agriculture and people out of floodplain
Engineer solutions vs. adaptive solutions.
Innovation
Small scale vs. big
Changes in thinking and management

See flooding as natural vs. problem
Timing: too late / in time
Reactive vs. proactive
At what point are people motivated to act?
How do we achieve resilience or sustainability?
Exploit different resources based on changing conditions
In-migration and growth vs. out migration and lower consumption
Social conflicts vs. environmental justice

Final Discussion

Workshop participants wrapped up the day's activities with a discussion of the scenarios.

1) How do the scenarios challenge the assumptions of current policies, such as the GMA?

- We have a conservative expectation of supporting and maintaining salmon populations. At what point do you start to let go of current expectations of a healthy environment? Or should our actions focus on supporting important values to control future conditions?

- Planning utilizes 20 year plans time frames, but perhaps we should also create 50 year plans, that are not actually plans, but rather scenarios to address uncertainty and evaluate the 20 years plans in the context of the longer time frames.

- What scenario are we in? How does that affect our thinking about the future?

2) Have any of the opportunities or challenges surprised you?

- Innovation may look very different based on national and international trends and values. How does the outside influence big scale technology? The Basin in context to global changes in important to consider.

- If we plan for 20 years, but resilience and vulnerability require that we look ahead 100 years, we may end up developing in a direction that may lead us to catastrophe.

- Futures may vary (be non-stationary) from decade to decade. We may jump from quadrant to quadrant in terms of the directions of the future. Today's drivers may shift.

A final note on the process

One thing that has surprised us in a positive sense is the similarity of outcome between the driver selection from this exercise and a similar exercise we conducted in the larger Puget Sound region with 50 scientists in a previous project. This might suggest that there is some level of robustness to this process, a hypothesis that would be valuable to test.

Scenario Development Meeting

Date

8.4.2011

Location

Gould Hall. UW Seattle.

Objective

Refine scenario logics and hypotheses developed at Scenario Logics Workshop.

Attendance

Ten science team members with disciplinary foci on climatology and social sciences r

Agenda

- Introductions
- Selection of variable and end states
- hypotheses development: each team developed a one line statement that summarizes the storyline or overarching assumption of each scenario. Teams also described changes in related trajectories in 3-5 phrases (i.e. in-migration of young, diverse and talented workforce).
- Discussion. Questions for UERL to test after meeting in order to finalize the scenarios.

Materials

Presentation (pages A6.104-106)

Pre-meeting handout - potential human value and climate change variables and trajectories (pages A6.107-108)

Synthesis

(pages A6.130-136)

Scenario Development Meeting

August 4th 2011

Scenarios for Snohomish Basin 2060

Develop an assessment of key ecosystem services in the Snohomish Basin by characterizing the uncertainty associated with alternative future baseline conditions.

a 2-year research agenda
Funded by the Bullitt Foundation

Meeting objectives

Refine the scenario logics developed at the Scenario Logics Workshop by selecting final variables, end-states and hypotheses.

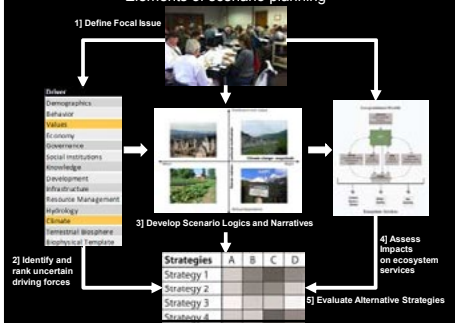
Agenda

- Brief introduction
- Selection of variables *[45min]*
- Development of hypotheses *[45min]*
- Discussion of next steps *[15min]*

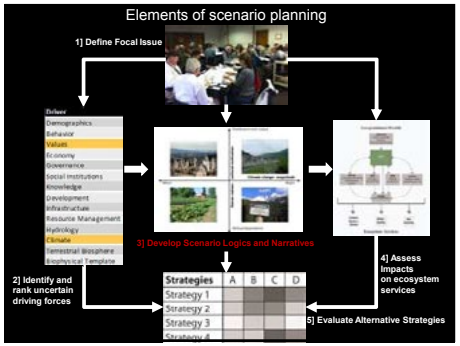
Project TIMELINE

2010	Winter	*Urban Planning Class*
	Spring	*Kickoff*
	Summer	*Interviews*
	Fall	Conceptual Model Workshop
2011	Winter	*Basin Assessment*
	Spring	Scenario Logics Workshop
	Summer	*Scenario Building Team*
		Integrated Model Workshop
	Fall	Policy Workshop

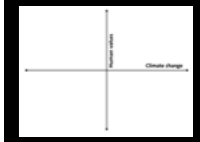
Elements of scenario planning



Elements of scenario planning



In Detail: Developing scenario logics and narratives

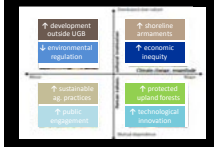


1. Selected driving forces create frames for scenario logics

In Detail: Developing scenario logics and narratives

1. Selected driving forces create frames for scenario logics
2. Participants select variables and end points for key driving forces

In Detail: Developing scenario logics and narratives



1. Selected driving forces create frames for scenario logics
2. Participants select variables and end points for key driving forces
3. Participants develop hypotheses about driver interactions

In Detail: Developing scenario logics and narratives

1. Selected driving forces create frames for scenario logics
2. Participants select variables and end points for key driving forces
3. Participants develop hypotheses about driver interactions
4. Participants develop scenarios with rich storylines

Synthesis: Scenario Logics Workshop

- **Driver Exploration:** Teams explored *14 driving forces* previously identified by the Science Team and selected the two most *important and uncertain* driving forces.
- **Driver Selection:** Participants discussed *criteria* for driver selection and *agreed* on the two most important and uncertain driving forces.
- **Scenario Logics:** Each team developed four *scenarios storylines* including variable *end-states*, *hypotheses*, characterized *trajectories* and *tradeoffs* associated with opportunities and challenges.

Initial Driving Forces

Human
- Behavior
- Demography
- Values

Institutions
- Economy
- Governance
- Knowledge
- Social Institutions

Built Environment:
- Development
- Infrastructure
- Resource Management

Natural Environment
- Biophysical Template
- Hydrology
- Climate Change
- Ecosystems

Most important and uncertain driving forces (votes)

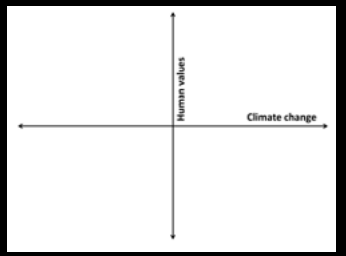
Human
- Behavior [5]
- Demography [4]
- Values [12]

Institutions
- Economy [6]
- Governance
- Knowledge
- Social Institutions [2]

Built Environment
- Development [4]
- Infrastructure
- Resource Management

Natural Environment
- Biophysical Template
- Hydrology [1]
- Climate Change [11]
- Ecosystems [5]

Refining the Scenario Logics



Potential variables and endpoints

Climate change:
- Magnitude (*major vs. minor change in annual mean precipitation & temperature)*
- Seasonality *(earlier vs. later precipitation peak)*
- Extreme Events (historic rates vs. frequent exceedance of temperature and precipitation)
- Snowpack *(historic levels vs. near extinction of snow water equivalent on April 1st)*
- *Scale of impact (local vs. global change)*

Human values:
- Cultural Motivation *(dominance over nature vs. mutual dependence)*
- Individual values (collectivism vs. individualism)
- Future valuation *(short vs. long term investments)*
- Consumer behavior *(high vs. low consumer spending)*
- Attitudes *(prioritization of environment vs. economy)*
- Awareness: *(high vs. low congruency between scientific knowledge & public opinion)*

Selecting variables and endpoints

Objective: Develop scenarios that are:
- Relevant
- Divergent
- Plausible
- Compelling

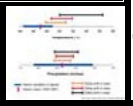
Relevant

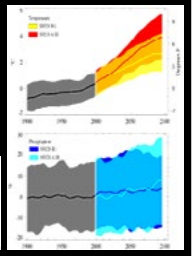
Focal Issue: *To maintain ecosystem services in the Snohomish Basin out to 2060*

Ecosystem Services
- **Water:** quality and quantity
- **Carbon:** storage and fluxes
- **Biodiversity:** species and landscape

End states example: *climate change*

Major Change	
IPCC Scenario	A1
Temperature	3.0degC increase by 2060
Precipitation	Increase in winter precipitation
Minor Change	
IPCC Scenario	B1
Temperature	0.5degC increase by 2060
Precipitation	No significant change in annual precipitation





End states example: *human values*

Variable	Mastery	Harmony
Relationship to natural and social world	master and change the world, to assert control, bend it to our will, and exploit it in order to further personal or group interests.	accept the world as it is, trying to fit in rather than to change or exploit it.
Cultural emphasis	*Getting* ahead through active self-assertion .	*Fitting harmoniously into the* environment .
Keywords	ambition, success, daring, competence	unity with nature, protecting the environment, world of beauty

Example hypotheses of driver interactions

Dominance over nature

cultural motivation

Climate change: ***magnitude***

Minor — Major

Human values:

Mutual dependence

Example hypotheses of driver interactions

High

Awareness

Climate Change: ***scale of change***

Local — Global

Human Values:

Low

Example hypotheses of driver interactions

Long term

Future valuation

Climate change: snowpack

Near extinction — Historic

Human Values:

Short term

Plausible

- Are the scenarios:
  - Logical?
  - Testable?
  - Grounded in theory?
  - Evidence based?
  - Internally consistent?

Compelling

- Are the scenarios:
  - Communicable?
  - Memorable?
  - Transformative?
  - Powerful?

Are the hypotheses divergent?

Dominance over nature

cultural motivation

Climate change: ***magnitude***

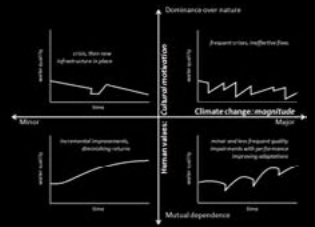
Minor — Major

Human values:

Mutual dependence

Are hypothesized implications on ecosystem services divergent?

Example hypotheses of baseline trajectories for water quality



CLIMATE CHANGE VARIABLES:

MAGNITUDE (potential indicator: change in annual mean precipitation and temperature): Magnitude refers to the extent of change in temperature and precipitation in terms of degrees and depth of rain respectively. The Intergovernmental Panel on Climate Change (IPCC) has brought forth several global models that reflect changes in both temperature and precipitation associated with variable levels of CO2 scenarios. Downscaled models have been applied to the Puget Sound and specifically the Snohomish Basin (Zhang, et al, 2009) to predict the magnitude of temperature and precipitation impacts at a finer resolution.

SEASONALITY (potential indicator: centroid of timing): The timing of precipitation can influence shifts in seasons with implications on runoff, streamflow and water availability. Precipitation trends roughly fall under heavier winter precipitation and lighter summer precipitation. Downscaled models show considerable variation in regional precipitation simulations for 2030 to 2059 (Salathe, 2010).

EXTREME EVENTS (potential indicator: exceedance of long term daily temperature and precipitation means): Extreme weather events such as heat waves, floods, droughts, or storms can lead to severe societal and economical impacts. Events are characterized as extreme if they exceeds (+/-1.5) standard deviations from the long-term means on a particular day (CIG website, 2011). Downscaled models have been developed for the Pacific Northwest that better represent local terrain and meso-scale weather systems, necessary to understanding processes causing localized extreme weather events (Duliere, 2009). Extreme events are tied more closely to changes in the variability than in the mean of climate change (Katz and Brown, 1992). Pacific Northwest models show an agreement for moderate increases in winter precipitation increasing the frequency of extreme events (Mote, 2003).

SNOWPACK (potential indicator: snow water equivalent, April 1st): Snowpack refers to layers of accumulated snow that may serve as temporary upland reservoirs of water. "The hydrology of the Pacific Northwest (PNW) is particularly sensitive to changes in climate because seasonal runoff is dominated by snowmelt from cool season mountain snowpack" (Elsner, 2009). Temperature changes influence whether precipitation will occur as rain-on-snow or snow-on-snow events. Warming trends are hypothesized to lead to a decline in snowpack. Relative declines grow from minimal at ridgetop to substantial at snowline. Transient Watersheds are likely the most sensitive to warming trends (Hamlet and Lettenmaier, 2007).

GLOBAL CLIMATE CHANGE (potential indicator: local versus global change): Climate changes may be greater outside the Basin (global or region) than within it leading to surprising and significant implications on the Basin. Global climate change models show variable future change with respect to temperature, sea levels, soil moisture and precipitation across the world (BBC, 2011). Further, a country's vulnerability and economic development compounds the effect of climate change. Currently, unstable developing countries and regions with critically threatened ecosystems have been the most affected by climate change (Thakker, 2009). However, richer countries incur higher damages in absolute dollars. Future global climate change may catalyze resource demands and economic opportunities in the Basin (i.e. in-migrations, agricultural productivity, and timber production).

HUMAN VALUES VARIABLES:

CULTURAL VALUES (potential indicator: dimensions of cultural adaptation)

Values are considered one of the most fundamental factors governing human behavior. Values are described as: beliefs, which when activated become infused with feeling; referring to desirable goals and modes of conduct; transcending actions and situations; guiding the evaluation of behavior, people and events; and as ordered by relative importance. Values prioritize behavior,

accounting for the initiation and direction of actions. Schwartz' research has supported the near-universality of ten types of individual values (1992). However, when moving to the level of cultural values, different issues and dimensions of values become relevant. One common dimension is individualism vs. collectivism. Schwartz alternatively identified three bipolar cultural adaptations: conservation versus autonomy, hierarchy vs. egalitarianism and mastery versus harmony (Schwartz, 1999).

FUTURE VALUATION (potential indicator: public investments in fixed public assets)

Future valuation, or simply put how much a society values the future, is important in understanding how much the public is willing to forgo certain current values in order to maintain benefits and reduce future risk. Understanding society's valuation of future conditions is fundamental to properly estimating the costs and benefits of major environmental policies (). Future valuation is directly related to intergenerational equity, or how much we value future generations. There are several means to measure future valuations. Economists, for example, measure future value by quantifying the discount rate. Investments in benefits that pay out over a long term are indicative of a high(er) future valuation.

CONSUMER BEHAVIOR (potential indicator: spending patterns in non-necessities)

Consumer behavior reflects how people behave when obtaining, using, and disposing of products (and services). Higher consumption rates have been associated with developed countries, with the United States having one of the highest ratings (Mooij, 2011). Consumption of resources has been linked to impacts on the natural environment, and more recently our carbon footprint (Hertwich, 2009). Consumer behavior can be measured not only through how much we spend, but also the types of (goods and services) (BLS, 2006).

ATTITUDE PRIORITIES: (potential indicator: prioritization of issues)

Priorities refer to the ordering of importance of topics or actions based on an individual's attitudes. Attitudes reflect favorable or unfavorable evaluations of an object. Values are less directly implicated in behavior, however are considered more durable than attitudes (Hitlin and Piliavin, 2004). Environmental attitudes are linked to socio-economic conditions and heavily influence political decisions.

AWARENESS: (potential indicator: congruency between scientific knowledge and public opinion)

Awareness refers to having knowledge and being cognizant of information. There is generally a delay between scientific knowledge and the transfer of that knowledge into the public domain (Boreaux, 2009). It is presumed that once the public is sufficiently aware of new knowledge, they will change their actions (i.e. consumption pattern, voting preference, activities) accordingly (Rochon, 1998).

Synthesis

I. Discussion of variable selection:

Human Values	Climate Change
Cultural motivation + individual values (mastery/individualism vs. harmony/collectivism)	*Great changes in extreme events vs. no changes*
Future Valuation (high value on immediate present vs. high value on long-term)	*Extreme events (historical norms vs. extreme variability)*
Cultural motivation + individual values (microeconomic valuation of ES vs. collectivist valuation)	*Extreme Events (higher frequency vs. lower frequency of extreme events)*
Consumer behavior (amount and type)	*Magnitude (minor change vs. major change)*
Cultural motivation (harmony vs. mastery)	**Magnitude and Variability (extreme events + major change vs. historical variability + minor change)**

Figure 1: Team selected variables and end-states (*italicized*) and agreed upon final selections (**bold**).

Climate Change

Extreme Events:

1. Can reflect both a change in frequency and magnitude of events. Should be defined, as exceedance of specific parameters.
2. Should not be limited to precipitation and temperature, but also changes in flooding, drought, soil moisture and frost dates.
3. A general increase in extreme events may still include a decrease of specific variables, for example flood.
4. One end-state can be historic variability; another could be decreased variability, or fewer extreme events. That might have implications on our behavior as it would reduce pressure (we are not currently well equipped to deal with even the current frequency of events). However, reduced capacity to handle extreme events (as documented in policy response due to low variability in the 40-70's) may reduce ecosystem resilience and lead to higher vulnerability to future perturbation.
5. The other variables (snowpack and seasonality) are highly correlated. The only one that isn't is global vs. local.

Magnitude:

1. Magnitude seems like a fundamental piece that we need to include.
2. Perhaps people notice extreme events more than long term increases, in let's say temperature. But we do also track magnitude changes, reflecting back to how things have changed.
3. Extreme events change the system, causing a shift by surpassing threshold. Magnitude can also shift the system, but it is less important.
4. The impact of a 'major' change versus extreme events is different. It is important to capture both dimensions in the scenarios. Could we include both of them along one axis, major and extreme events vs. minor and historic variability? Or are the two poorly correlated, could we have an extreme events and minor magnitude change? The most logical and divergent end states can be combined.

Human Values

Control: Selected variables should not reflect what decision makers in the Basin can control.

1. Consumer behavior and future valuation may be influenced by internal drivers (in addition to external drivers).
2. While climate change may be outside the realm of Basin decision makers' control, human values is affected by our actions. How does that affect human values variable selection?
3. Is consumption controlled more than a mastery/harmony or modes of production? Dimensions of consumption can relate to type, not just amount. For example, disposable consumptive spending vs. 'greener' spending.

Correlation: *Is individualism correlated with mastery?*

1. Individualism and mastery, and collectivism + harmony are more common cultural combinations, but the other combinations (individualism + harmony, and collectivism and mastery) can occur and are present in other nations or sub-cultures.
2. Collectivism and harmony may well represent collectivist modes of production, while individualism and mastery may reflect market based production systems. However, individual and harmony isn't broad enough to capture various institutions. While less probable, it should not be eliminated.
3. Does the axis of individualism + mastery and collectivism + harmony reflect more divergent endpoints? Yes. But not necessarily the most divergent scenarios. Outliers are an important element of scenarios,
5. Can we capture some of the ideas of individualism vs. collectivism and short vs. long term valuation while keeping mastery and dominance as the major dimension? Yes. By simplifying multiple dimensions along one axis we may be eliminating alternatives that are plausible and compelling.

II. Discussion of hypotheses and potential trajectories of the other drivers

Scenario 1: *Minor change and less extreme events + cultural motivation led by harmony*

- Overarching Idea: Low pressure, collectivist solutions. 'recovery'
- Implications to Ecosystem Services: Best possible scenario. Potential for improvements.

Other drivers:

1. Development: compact growth
2. Technology: biomimcry
3. Demography: more equity
4. Economy: away from market based solutions.

Scenario 2: *Major change and extreme events + cultural motivation led by harmony*

- Overarching idea: higher pressure met with collectivist patterns
- Implications to ecosystem services: diversification. Potential for maintenance (mitigation)

Other drivers:

1. Resource management: scarcer resources and diversified management practices
2. Development: compact efficient pattern, move uphill from flooding
3. Infrastructure: retreat from natural disasters.
4. Economy: pattern of production towards collectivism + more efficient use of resources.
5. Social Institutions: smaller, more community-based

Scenario 3: *Minor change and fewer extreme events + cultural motivation led by mastery*

- Overarching idea: 'status quo', similar pressure and values to today. Lower diversity.
- Implications to ecosystem services: slow decline. Expansion of utilization.

Other drivers:

1. Technology: will innovation keep pace? Biomimcry?
2. Resource management: more homogeneity. increased extraction. Depletion.
3. Infrastructure: higher demands for energy.

Scenario 4: *Major change and extreme events + cultural motivation led by mastery*

- Overarching idea: technocratic society working to innovate and compete our way out of climate challenges. 'worse'.
- Implications to ecosystem services: uncertainty, shortages and crises. high stress.

Other drivers:

1. Technology: high reliance on innovation. 'techno-fixes'
2. Demography: inequality, disproportionate distribution of impacts
3. Infrastructure: more built, protection
4. Resource management: shortages and conflicts. higher focus on resource management.

Discussion Questions:

1. What are the limits? This is both a temporal and spatial question. We may see a shift towards another 'quadrant / scenario' if our actions do/don't work.
2. Where are we right now? (which scenario)
3. What might the implications of climate change be on environmental regulation? What is the relationship between regulation and cultural motivation?

Interviews with Predictive Modelers

Date

9.2011

Location

UW Seattle

Objective

To understand more about each model (structure, assumptions, and theory) and to evaluate the potential for integration.

Attendance

Interviews were conducted with individual or small groups of predictive modelers representing a regional model.

Materials

Survey Instrument - see page A6.112

Synthesis.

See Appendix 2 Predictive models and integration

SURVEY INSTRUMENT FOR INTEGRATED MODEL

Introduction

This interview is part of the modeling component of the Snohomish Basin Scenarios Project. The objective of the Snohomish Basin Scenarios project is to inform strategies for long term protection of ecosystem services in the Basin. The modeling component aims to explore how existent models can be integrated to evaluate future ecosystem service conditions in the Basin, under alternative scenarios.

The Snohomish Basin Scenarios project engages experts in the development of scenarios that propose divergent hypotheses for how the future can unfold in the Basin. These scenarios are combined with predictive models to quantify key ecosystem services in the Basin under alternative futures. The suite of scenarios and assessments allows decision makers to select robust strategies that are effective under divergent trajectories. The scenarios help highlight opportunities and challenges that may otherwise be overlooked through assessments culminating in a single prediction or vision for the future.

The project includes four components 1) conceptual model and Basin assessment 2) scenario logics 3) integrating predictive models and 4) supporting decision making through an evaluation framework.

During the first phase (conceptual model and Basin assessment) we interviewed Basin and regional experts to look at what factors drive urban growth and environmental change in the Basin. Interviews were followed up with a Conceptual Model Workshop in which experts built a framework for asking the question 'what is the future of the Snohomish Basin look like?' This information will be compiled in an assessment of the current state of key ecosystem services as a State of the Basin Report.

The second and third phases which involve developing scenario logics and identify predictive models, occur concurrently. The scenario logics are hypotheses describing alternative future baseline conditions in the Basin in 2060. Regional experts and stakeholders are asked to develop these logics by selecting the most important and uncertain drivers influencing the Basin's future at the Scenario Logics Workshop.

The model integration piece, which this interview is a component of, is the third phase of the project. In order to quantify baseline conditions of ecosystem services under alternative scenario logics, we will be exploring how to integrate existent regional models. We will also investigate which parameters, starting conditions or model assumptions could be modified to represent the status or trend of the driving forces from each scenario. The ecosystem services we are interested in modeling include those related to biodiversity, water (quality and quantity) and carbon (storage and fluxes).

Finally, the project team will develop evaluation criteria to inform the selection of robust strategies that effectively maintain ecosystem services across alternative futures. By understanding the full range of opportunities and challenges we may face, even those less probable or outside our realm of influence, we can identify a more robust and adaptable suite of strategies to protect the future of the Basin.

Do you have any questions about the project in general?

As I mentioned earlier, today's interview is aimed at informing the integrated model phase of the project. Our objectives are to understand more about the model (structure, assumptions, and theory) and to evaluate the potential for integration. Based on these interviews we will develop a white paper that summarizes a selection of appropriate regional models. An Integrated Model Workshop will be held to explore ways to integrate identified models to evaluate future baselines that are sensitive to differences represented in the scenarios.

Model Characteristics

1. Please describe the *name of* model for us.
2. What is the purpose of the model?
3. What is the output?
4. What are the assumptions?
5. What is the modeling approach?
    a. Equations/models/theory (Monte Carlo, linear regression, etc)
6. What systems (or predictor variables) are represented explicitly within the model? Which are endogenous, exogenous (parameters)?
7. Which is the model most sensitive to (or drives the outcome)?
8. What is the model input?
9. What is the spatial and temporal scale (resolution and extent)?
10. What are the current model limitations? Assumptions?
11. How is uncertainty treated/represented in your model?

Model Output

1. Describe the range of the model outputs? Are there multiple output modes?
2. Describe the most divergent endpoints (realized or expected)? What is the model output most sensitive?
3. What are future developments (currently planned, or in early stages) for the model?

Integrating Models

1. What, if any, models has *model name* been integrated with?
2. How has it influenced the scope and extent of model predictions?
3. Which additional model (specific or type) might *model name* be paired with?
4. During the CarbonFinity Workshop (which you attended), MIMEs was proposed as a systems based platform that links existent regional models to assess ecosystem services. What are your thoughts on its use? Did you find it was helpful or limiting?

Expanding our Research

Handout: Provide a list of the identified models and contacts.

1. Are there any publications we could look at to understand more about *model name*?
2. What other models would you recommend we look at?
3. What other agencies or experts should we be contacting to complete our assessment? (show list)
4. Do you have any recommendation for our modeling workshop?

Interview Wrap Up

1. Do you have any final suggestions, considerations or questions for us?

Integrated Model Workshop

Date

11.3.2011

Location

Peterson Room. UW Seattle

Objective

Discuss how regional models can complement the Scenario Planning approach in characterizing long term implications of multiple uncertain drivers. During the workshop we will focus on drafting a blueprint for integrated modeling to assess future conditions of ecosystem services in the Snohomish Basin [WRIA 7] under alternative scenarios. The models we are currently investigating include Shiraz, DHSVM, HSPF, WRF, LCCM, UrbanSim and EcoPath. We are also exploring the possible links between the model outputs and InVEST and the DOE's Watershed Characterization Model.

Attendance

Ten science team members with disciplinary foci on regional predictive models.

Agenda

- Presentation: how can models help scenarios expand our ability to characterize uncertainty?
- Team exercise 1: explore the relationships between scenario and models
- Team exercise 2:draft model integration
- Discussion: Potential benefits and limitations of model integration

Materials

> Presentation (pages A6.114-121)

> Pre-Meeting handout - Draft scenarios and indicator trajectories across draft scenarios (A6.122-128)

> Summary of selected predictive models (A6.129)

> Driver Forces Future Trajectories Database

Workshop participants were sent a web-based spreadsheet relating the draft four scenarios with the 14 driving forces identified by the Science Team. Each driving forces is described through a selection of 2-5 indicators. The main page includes a brief summary the historic trajectory of each indicator, the spatial and temporal extent of the available data and potential future trajectory in association with each scenario. Details on each indicator can be reviewed by clicking on the hyperlink to reveal a summary worksheet including a description, graph, raw numbers, and references. The selection of indicators was based on recommended good measures of the driving force, available data and relevance to the draft scenario narratives. After the workshop, the UERL team discussed the selection and trajectories of each indicator with science team members to assess if: 1.They are appropriate? If there are indicators that may be more applicable? easier to communicate? available data? more direct? 2.To see if experts agree with the trends depicted? Do they agree with the direction of the trends?

The database of indicators and trajectories can be found here:

http://www.urbaneco.washington.edu/sbs/docs/data/7631_SBS2060.xlsx

Integrated Model Workshop

November 3rd 2011

Project Objective

Develop an assessment of key ecosystem services in the Snohomish Basin by characterizing the uncertainty associated with alternative future baseline conditions.

a 2-year research agenda
Funded by the Bullitt Foundation

Project TIMELINE

2010	Spring	*Kickoff*
	Summer	*Interviews*
	Fall	Conceptual Model Workshop
	Winter	*Basin Assessment*
2011	Spring	Scenario Logics Workshop
	Summer	*Scenario Development*
		Model Assessment
	Fall	Integrated Model Workshop
	Winter	Policy Workshop

Thank you to our Science Team
our primary source of support

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Workshop Objectives

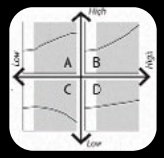
Workshop objectives are to draft a blueprint for an integrated model and select indicators of Ecosystem Services sensitive to different trajectories of alternative scenarios?

Workshop Agenda

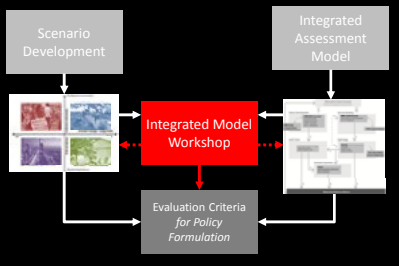
- **12:00-12:30** Lunch and Presentation by Alberti, Puruncajas and Russo
- **12:30-1:00** Exercise 1: *Explore the relationships between scenarios and models*
- **1:00-1:30** Exercise 2: *Ecosystem Services Indicator Selection*
- **1:30-2:30** Exercise 3: *Model Integration*
- **2:30-3:15** Blueprint Presentations
- **3:15-4:00** Model Integration Discussion

Project approach

Instead of focusing on a single trajectory or prediction, we use Scenario Planning to explore alternative plausible futures and highlight the risks and opportunities involved in strategic decisions for the basin development.

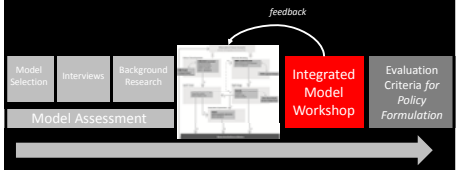


How did the process inform the workshop, and how will the workshop inform the overall process?



Scenario Development

Integrated Model



HOW CAN MODELS SUPPORT SCENARIO PLANNING?

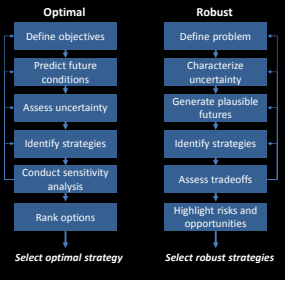
Why multiple scenarios

- Strategies aimed to maintain ecosystem services require looking beyond **current** baseline conditions.
- Scenarios help highlight potential threats and opportunities that can emerge from interactions among **uncertain** driving forces
- Alternative scenarios challenge our assumptions about how the future can play out to help identify **plausible futures**
- *'the objective of good scenarios is better decisions not better prediction' (Dearlove 2002)*

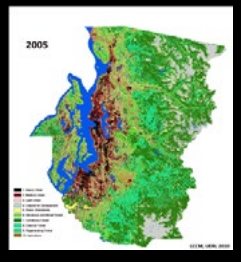
How do scenarios help make better decisions

- Characterize uncertainties of future conditions
- Identify sensitivity of strategies to uncertainties
- Seek robust rather than optimal policies: Select robust strategies (performance is insensitive to uncertainties)
- Facilitate developing adaptive plans and strategies by highlighting warning conditions of failure scenarios
- Provide algorithms for inference that can complement models with incomplete data

Decisions under uncertainty

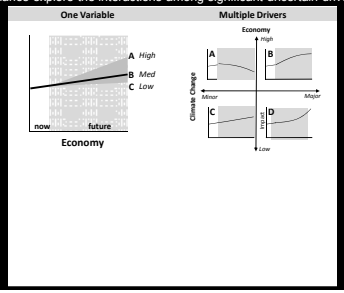


Predictive Models



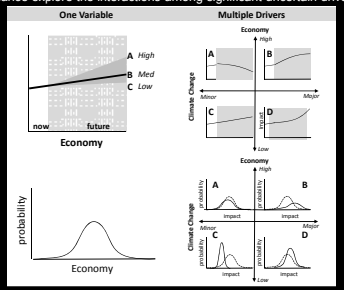
Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers



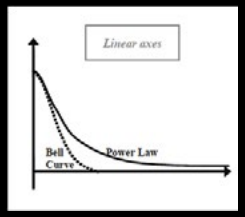
Uncertainty of Multiple Drivers

Scenarios explore the interactions among significant uncertain drivers



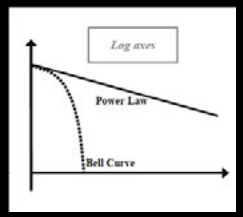
Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers



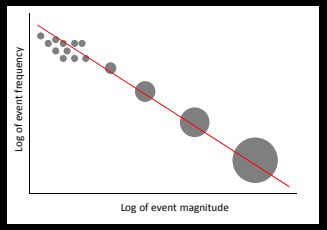
Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers



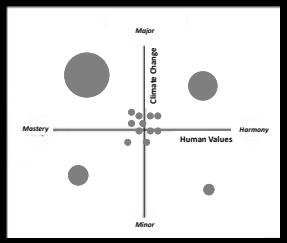
Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers



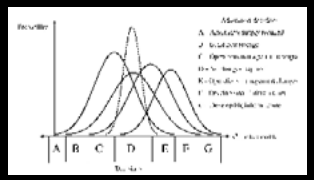
Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers



Low Probability High Impact

Scenarios explore the interactions among significant uncertain drivers



Scenarios and Models

- Scenarios
  - Define alternative, plausible, and most divergent futures and uncertain trajectories that affect ecosystem services over the long term
- Models
  - Predict impacts of alternative futures on

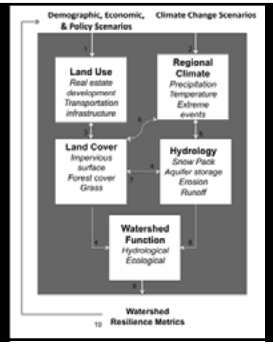
Potential Relationships

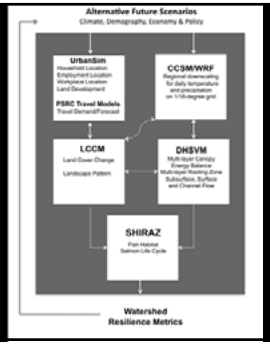
Models to Scenarios

- Refinement of relationships
- Hypothesis (testing)
- Impact assessment

Scenarios to Models

- Expand boundary conditions
- Explore inclusion of additional parameters and variables
- Identify gaps in knowledge
- Characterize uncertainty





Integrated Models

- Problem definition
- Multiple actors
- Time scale
- Spatial scale
- Feedback
- Uncertainty

10 models reviewed

SELECTED MODELS

Model Selection Criteria

- Models that represent at least one of the 6 ecosystem service areas (species and habitat biodiversity, water quality and quantity and carbon storage and fluxes) or identified significant drivers of the outcome of interest (e.g.. land cover change).
- Models with a high level of development (ideally have undergone a scientific peer review)
- Models that have been developed specifically for the study area (Snohomish Basin or Puget Sound lowland region).
- Models with a flexible structure that can easily be (or that have already been) integrated with output from others models were a high priority.

Selected Models

Interviews with Modelers

1. Purpose
2. Model type
3. Spatial and temporal scale
4. Input, output
5. Assumptions and limitations
6. Uncertainty
7. Integration with other models

Summary Table (handout)

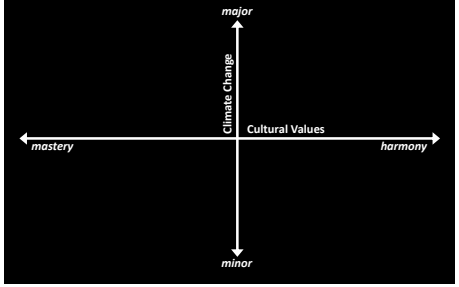
Model Elements

- Variables: input / output
- Boundary conditions
- Spatial and temporal scale (resolution, extent)
- Uncertainty
- Feedbacks, model integration
- Gaps in knowledge

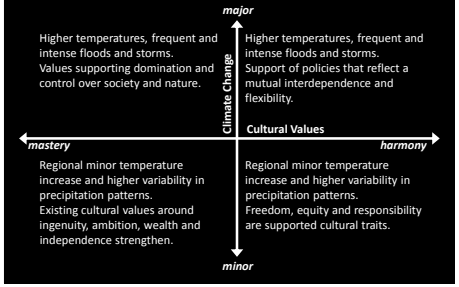
Snohomish Basin 2060

SCENARIO DEVELOPMENT

Scenario Logics



Scenario Hypotheses



Scenarios

Scenario Development

Climate Change:

Major + Extreme

- ↑ 1°C / decade
- ↑ 0.1"/ decade Precipitation
- ↑ frequency + intensity of HW + DTR
- ↑ flooding and storms
- ↓ snowpack
- Fast streamflow
- Poor water quality
- Damages to infrastructure / property
- Ecosystem regime shift
- ↓ habitat quality
- *Confounding Uncertainty: Pace??*

Minor + not extreme

- ↘ rate of climate change
- ↑ 0.2°C / decade
- No clear precipitation change
- ↘ snowpack
- ↗ floods
- Shift in temperature sensitive plants and animals
- *Confounding Uncertainty: Apathy / proactive response??*
- *Confounding Uncertainty: Scale of change ??*

Cultural Values

Mastery

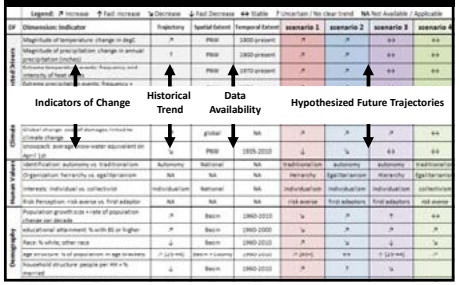
- getting ahead through active self-assertion over the natural world and society.
- ↑ traits: ambition, success, and competence.
- ↑ infrastructure and reliance on technological solutions that restrict change and direct benefits towards human resource needs.
- + w/Hierarchy: legitimize unequal distribution of power, rules and resources.
- *Confounding uncertainty: top-down regulations or free market exchange??*

Harmony

- accepting the world as is and trying to fit in rather than changing the natural world and society.
- ↑ attitudes: environmental protection, peace and unity
- ↑ strategies that minimize environmental degradation and support redistribution of personal wealth.
- + w/egalitarianism: prioritizes a voluntary commitment to promoting the welfare of others through freedom, justice and honesty.

(Revised) Conceptual Model

Scenario Trajectories



Scenario Development

Dimensions of Driving Forces to represent the scenarios

EXERCISE 1: EXPLORE THE RELATIONSHIPS BETWEEN SCENARIOS AND MODELS

Prioritize Driving Force Dimensions

Objective

- Identify which dimensions can best represent our scenarios?
- Identify which dimensions can be modeled?
- Identify what information could complement selected dimensions to support predictions of future change?

Step 1: telling a good story

- Team up (2 people per team). Look over scenarios. Review list of dimensions.
  - Which dimensions seem most critical to telling the story?
  - Which dimensions can be left out?
  - Are there additional dimensions / measures that should be included.

Step 2: selecting appropriate measures

- Of the indicators that you prioritized, highlight which ones:
  - – are available?
  - – are relevant?
  - – represent model input variables?

Step 3: bringing ideas together

- After highlighting dimensions, share your selection with your table-mates.
  - Assign one person to be the secretary.
  - Review which dimenions you prioritized.
  - Bring your lists together.

A few more details

- 4+1 tables of dimensions
- Notepad + highlighters
- Scenario descriptions, summary table of models are available in packet.
- You have 30minutes. May we suggest:
  - 20min in 2-people team
  - 10 minutes to synthesize together

Indicators to determine outcomes

EXERCISE 2: ECOSYSTEM SERVICE INDICATOR SELECTION

Prioritize Ecosystem Service Indicators

Objectives

- How can we quantify scenario outcomes as alternative future baseline conditions of ecosystem services (ES)?
- What are potential indicators of ES for water quality + quantity, biodiversity and carbon stocks + fluxes?

Step 1: review list of indicators

- Team up (2 people per team). Review list of indicators.
- Which indicators are the best measures of:
  - Water Quality?
  - Water Quantity?
  - Species Diversity?
  - Habitat Diversity?
  - Carbon Stocks?
  - Carbon Fluxes?
- Which ones can be eliminated?
- Which additional indicators should be included?

Step 2: Rate Indicators

- Of the indicators you highlighted as good measures. Which ones are the most:
  - Relevant and Informative?
  - Available?
  - Modeled?

Step 3: bringing ideas together

- After highlighting indicators, share your selection with your table-mates.
  - Review which indicators you prioritized.
  - Bring your lists together.

A few more details

- Brief descriptions and references are available in packet.
- You have 30minutes. May we suggest:
  - 20min in 2-people team
  - 10 minutes to synthesize together

Bringing models together to explore scenarios

EXERCISE 3: MODEL INTEGRATION BLUEPRINT

Step 1: Review Working Pieces

- List of models
- List of prioritized indicators of driving forces
- List of prioritized indicators of ecosystem services
- Large format paper, markers, post-its
- Legend

Step 2: Draft a Blueprint

- Pair up.
- Draft connections between the various models.
- Illustrate:
  - Flows (solid arrows) into and out of models.
  - Feedbacks (dashed arrows)
  - Variables (name indicators) as going into, out of, or within model
  - Gaps in knowledge (?)

Step 3: Bringing Ideas Together

- Shares blueprint with table-mates.
- Bring models together.

Step 4: Test drive Scenarios

- "Run" (hypothetically) the scenarios through the model blueprint.
- Iteratively run each scenarios by following the flow of the model.
  - Start with the scenario logics (climate and values endpoints.
  - Denote changes to driving force indicators
  - Denote changes to ecosystem services indicators

Discuss

- Is the model sensitive to differences between the scenarios?
- Which driving force indicators may influence the boundary conditions of current models? (highlight)
- Which indicators of ecosystem services best represent differences between the scenarios given the model structure? (highlight)

A few more details

- You have one hour. May we suggest:
  - 20min draft initial blueprint (2-people team)
  - 20min synthesize models together
  - 20min run scenarios
- Secretary: write down important discussion points.
- Presenter: Write down major linkages and challenges of model. List critical indicators (of both DF + ES). 5 min per table.

Share draft model with everyone

BLUEPRINT PRESENTATIONS

Discussion of Draft Models

- Are the models sensitive to differences between the scenarios?
- What are the models good at predicting? What are they poor predictors of?
- What are critical questions raised by model integration?

Benefits and challenges

MODEL INTEGRATION DISCUSSION

Benefits of Model Integration

- What are potential benefits of model integration?
- In what ways can models best support the scenario planning process?
- Can uncertainty be more formally characterized through an integrated model?
- Can scenarios expand the consideration of uncertainty in model predictions?

Challenges to Model Integration

- What are potential challenges and limitations to model integration?
- What are the current gaps in our knowledge?
- What are current gaps in model components and empirical data necessary for modeling the impact of the future scenarios on the selected ecosystem services?
- What are impeding inconsistencies between models (scale, variables, approach)?

SNOHOMISH BASIN SCENARIOS

Rationale: This document presents four scenarios that explore plausible future conditions in the Snohomish Basin with divergent implications on maintaining ecosystem services[1]. The scenarios describe shifts in baseline conditions that influence the efficacy of our decisions but whose trajectory is uncertain. Scenarios help organize expert perspectives to characterize future uncertainty when past conditions are not sufficient and our ability to assign probabilities to predictions is limited. Our goal in describing the following scenarios is to challenge our collective assumptions of how the future can unfold in order to test the efficacy of alternative strategies[2] in a more inclusive manner. Our objectives are therefore to describe relevant, plausible, compelling and divergent scenarios that can teach us something new about long-term planning the Snohomish Basin. The probability of any one of the four scenarios depicted below being the real future is very small. Despite our tendency to select one scenario as either a desired or most probable future and dismiss the others, exploring the implications of the entire suite should provide additional insight to support more informed, flexible strategies that hopefully lead to a more resilient Basin ecosystem.

Methods: The current scenarios are the outcome of multiple iterative collaborations of the Science Team. The first step involved interviews with 78 regional experts to identify current and future driving forces influencing the state of the Basin and a conceptual model linking the drivers together. At the Scenario Logics workshop, participants reviewed the 14 potential drivers and identified climate change and human values as the two most important and uncertain drivers. On August 4th, a subset of members with expertise in the selected drivers refined four endpoints for the scenario logics by specifying variables for each driver. For climate change, participants selected a major versus minor magnitude of temperature and precipitation and frequency and intensity of extreme events. For human values, participants selected a 'mastery' versus 'harmony' cultural value. Descriptions of the implications of each endpoint are included on the following page. Draft scenario hypotheses were refined through dialogue with individual Science Team members. Over the last three months, a team at the Urban Ecology Research Lab reformatted the Conceptual Model to reflect the hypotheses structured by the scenario logics (see table 1). The research team explored past trends of indicators describing each of the 14 driving forces. The team then composed the scenarios by describing potential changes in future trajectories of each indicator, under each scenario (see table 2). Changes largely fell under three categories: 1) changes that are a direct result of logics (i.e. endpoint interactions), 2) changes that are related to potential variations associated with uncertain trajectories of pathways of driving forces. We selected the variations that created the most divergent or compelling storylines and 3) changes that cascade from the former two changes (see table 3). Over the next two months, these scenario narratives will be vetted and finalized through phone meetings with selected Science Team members focusing on the plausibility of future trajectories and interactions between drivers. In addition to the indicators of driving forces, hypothesized future trajectories of ecosystem service indicators will be associated with each scenario. These future baseline conditions will serve as starting point for evaluating the efficacy of alternative policies for maintaining current levels of ecosystem services in the Basin.

[1] This project specific ally explores six dimensions of ecosystem services including water quality and quantity, carbon fluxes and stocks and biodiversity at the landscape and species level.
[2] The focal question for this project and the intent behind the development of strategies is how to maintain ecosystem services in the Snohomish Basin by 2060.

DESCRIPTION OF SCENARIO LOGICS ENDPOINTS:

Major Climate Change: A "major" climate change in the Region can be characterized by rise in temperature by 1degCelsius and 0.1" of annual precipitation per decade. This would be coupled with an increase in the frequency and intensity of extreme events leading to strong precipitation and wind storms, flooding, and heat waves. Consequently, the majority of snowpack would be gone, the Basin's waterways would incur rapid streamflow, poor water quality due to higher temperatures, and increased runoff, buildings would incur costly damages and infrastructure would be disrupted by unreliable availability of resources and repair closures. Natural systems would be affected by shifting regime and degrading quality (water and habitat). A confounding dimension of uncertainty is the pace of change. If change occurs very quickly Basin decision makers will have very little time to prepare, consequently response may need to be immediate and reactive.

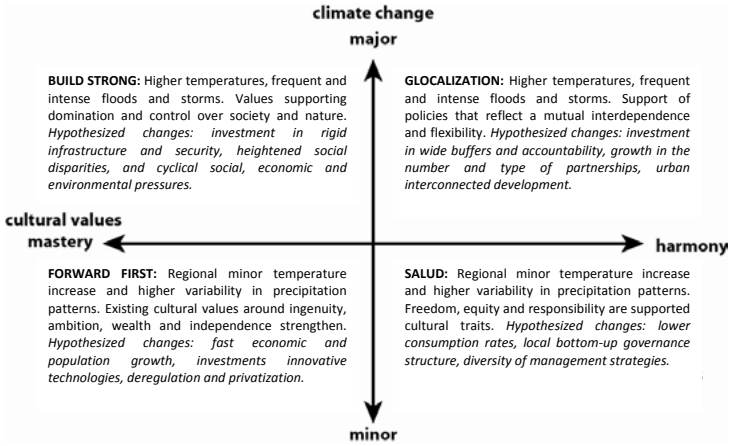
While the Basin already experiences severe floods, a major climate change would result in both a higher frequency and more intense flooding of the Basin's lowland.

Minor Climate Change: Based on past observations of climate change, the notion of no climate change occurring is not possible. However, over the next fifty years we may see a declining rate of climate change resulting in an increase of 0.2deg Celsius and no clear trend in annual precipitation. Even small degrees of climate increase would result in decline of snowpack, increase in lowland flooding and shifts in temperature-sensitive plants and animals. Consequent low short-term pressures on environmental, social and economic resources may be either temporarily overlooked, leading to societal apathy or proactively managed leading to increased ecosystem resilience. A confounding dimension of uncertainty is whether we experience the same level of minor change globally, or if the region is disproportionately spared.

Mastery Human Values: A "mastery" human value is characterized by a cultural emphasis on getting ahead through active self-assertion over the natural world and society. Mastery values include traits such as ambition, success, and competence. Mastery values would correspond with personal behavior and support of decision that attempt to master and exploit the world in order to further personal or group interests. Consequently, the Basin would invest in infrastructure and reliance on technological solutions that restrict change and direct benefits towards human resource needs. Mastery values correlate positively to hierarchy values which legitimize unequal distribution of power, rules and resources. A confounding dimension of uncertainty is whether control is achieved through top-down regulations or free market exchange.

Bioengineering solutions, while appreciating ecological health, seek innovative strategies to manipulate environmental services towards greater societal benefits.

Harmony Human Values: Harmony values are characterized by cultural emphasis on accepting the world as is and trying to fit in rather than changing or exploiting the natural world and society. Protection of the environment, peace and unity are valued attitudes. Harmony values correspond with personal behavior and support of decisions that protect equity and conserve environmental resources. Consequently the Basin would invest in strategies that minimize environmental degradation and support redistribution of personal wealth. Harmony correlates positively with egalitarianism which prioritizes a voluntary commitment to promoting the welfare of others through freedom, justice and honesty.



Scenario Logics and key themes

SUMMARY OF THE FOUR SCENARIOS

BUILD STRONG [major / mastery]: By 2060, the

Basin can based be described by a divided population and cycles of intense success and failures. Frequent hazards from flooding and storms damage lowland properties leading to investments in infrastructure projects that minimize natural change and secure assets. Short term (10-20 years) benefits include job growth in government and construction and stable conditions in select protected areas. Immediate and prevalent environmental problems that affect well-being are prioritized while challenges that emerge slowly are harder to control and leave the Basin vulnerable to surprises. Meanwhile, the cost of living has dramatically increased due to costly damages to unprotected resource and built lands and a rise in the cost of oil. Social disparities in wealth and well-being rise as the low-income groups fall further into debt while wealthier households secure private services and global goods. Society divides; the 'have-nots' increasingly resort to disruptive behavior (rioting, theft, illegal waste disposal, development without permits, etc.) while the 'well-to-do' barricade from social and environmental challenges (upland gated communities, personal vehicles, household purification systems, etc.). The number and scope of enforcing regulations escalate rapidly attempting to minimize further environmental and social damages (more permits, more restrictions and more oversight). Government funds are diverted towards emergency services and away from education, health and other social services. The amount of impervious surfaces, waterway hardening and commuting time in the Basin has tripled. By 2060 the rich live safely upland while for the poor degraded water and food quality, insufficient services, and declining health have become epidemics.

GLOCALIZATION [major / harmony]:

Early in the century, multiple factors came together to enable the support and implementation of proactive, integrated and adaptive investments that consequently alleviated the impacts of major climate change on economic, social and environmental systems in the Basin. While climate changes did occur, a slow rate of increase pushed most of the change towards mid-century. The Basin's affluent and educated populace and abundant natural resources came together to redistribute wealth and invest in a collective future. Households demanded full-cost accounting and transparency from both private industry and government. The Basin became globally renowned for its best-practice approaches and high quality of life resulting in strong pressure for industry growth and in-migration. Innovative programs resulting from public-private partnerships funneled much of the growth into newly emerging urban centers, served by innovative green utilities, a connected multi-modal transportation system and buffered with protected resource lands. By the time the Region experienced higher temperatures and shift in extreme events the Basin had built up an adaptive capacity and inter-agency monitoring system. There were still many challenges along the way, from newly emerging diseases to public disagreement over initiatives and priorities; however the duration and intensity of crises were dampened by a flexible, buffered and diverse hybrid social-ecological system.

FORWARD FIRST [minor / mastery]: The Puget

Sound region experiences minor climate impacts, while evidence of global climate change is characterized by unprecedented rate of natural disasters, economic and political destabilization and human suffering. Existing cultural values around ingenuity, ambition, wealth and independence strengthen. The Basin enjoys a competitive economic advantage due in part to its low environmental pressure, available educated workforce and a high global demand for regional products. Society does value environmental health, but sees laissez faire markets spurring innovation and competition as the best strategies for alleviating environmental problems. Rapid economic growth around port activities and resource and bioengineering industries lead to an infusion of private wealth and capital into the Basin. Private industry invests in the Region's economic future with world-class innovative resources, from alternative energy to connected light rail and academic institutions. Corporations also invest in the quality of life of their workers, purchasing natural lands for passive and active recreation , supporting cleanup efforts and funding regional research opportunities. By mid-century the Basin is largely deregulated and owned by private corporations. However, an almost exclusive reliance on technological innovation and private entities leaves a major blind spot when unanticipated challenges emerge. As the rate of growth increases so does the rate of new environmental problems and consequent innovations. By the end of the century the Basin struggles with a cacophony of tangled

innovations trying to gain ground on an ever-growing list of social-environmental challenges.

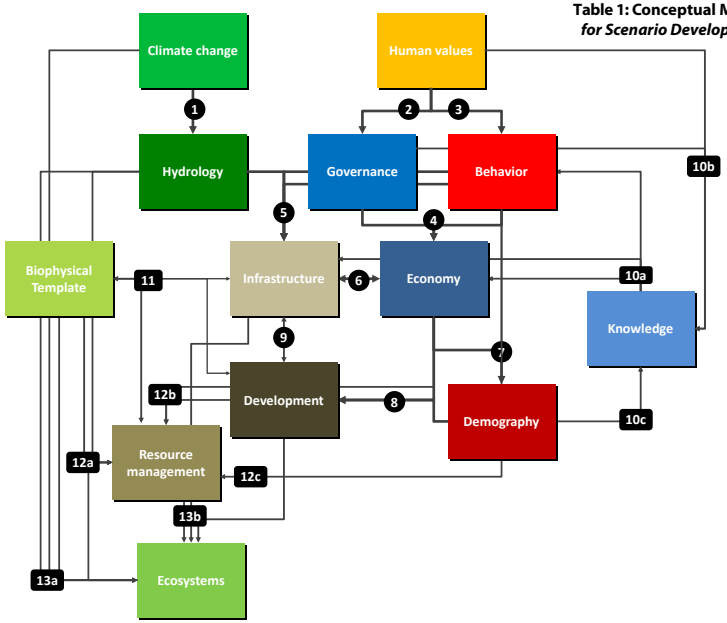
SALUD [minor /harmony]: After more than a decade of unsuccessful attempts to stabilize economic growth, society has adapted to alternative tactics for achieving a high quality of life. Households grow as traditional families and friends move back together for mutual support. Consumption levels decline as wealth declines, and resources are more efficiently managed through sharing, reuse and repair. Low property values and growing interest to 'live in harmony with nature' fuel migrations back into the Basin's resource lands. However the 'new farm' bears little resemblance to its predecessor characterized by small parcels, optimistic and highly educated young managers, and a humble deep ecology ethic. Numerous grass-roots organizations spring to support informal new communities from neighborhoods to shared interests. Family, public and environmental health, and leisure are promoted over work centrality and the notions of freedom, equity and responsibility surface as sought after traits. Climate impacts, while minor, are apparent to a demographic that is intimately close to the landscape. Past restoration actions are revealing benefits and enthusiasm over past successes has catalyzed exponential growth in the number of volunteers and provision of public funds towards restoration actions. There is a great variation in management strategies, at all scales. Despite highly accessible information there is little coordination between the growing number of institutions. Economic growth has been slow but steady. While initially lower expenditure rates threatened economic stability, strong local support for regional industry eased the transition to a new economy with a high diversity of sectors providing flexibility and adaptive capacity. While ratings of quality of life are higher, the Basin is constantly challenged with failed experiments, lack of coordination and global isolation.

COMPARISON OF DRIVING FORCES INDICATOR TRAJECTORIES ACROSS THE 4 SCENARIOS

This linked spreadsheet relates the above four scenarios with the 14 driving forces identified by the Science Team. Each driving forces is described through a selection of 2-5 indicators. The main page includes a brief summary the historic trajectory of each indicator, the spatial and temporal extent of the available data and potential future trajectory in association with each scenario. Details on each indicator can be reviewed by clicking on the hyperlink to reveal a summary worksheet including a description, graph, raw numbers, and references. The selection of indicators was based on recommended good measures of the driving force, available data and relevance to the draft scenario narratives. Over the next month we will discuss the selection and trajectories of each indicator to assess if:

1. These the appropriate indicators? Are there indicators that may be more applicable? Easier to communicate? Available data? More direct?
2. Experts agree with the trends depicted? Do they we can make these inferences? Do they agree with the direction of the trends?

Table 1: Conceptual Model *for Scenario Development*



The diagram highlights the relationships between driving forces used in the formation of scenario narratives. While this diagram stems directly from the Conceptual Model developed by the Science Team, it not inclusive of all relationships and feedbacks.

1] Changes in temperature and precipitation, as well as snowpack, influence hydrology by changing the streamflow, morphology, flooding, water quality and water quantity
2] Human values influence behavior including how we relate and perceive nature, what we invest in, and level of consumption.
3] Human values also influence the type and strength of governance we support (e.g. singular and strict versus multiple partnerships)
4] Governance (regulation and incentives) and behavior (consumption rate and investments) influence regional industry and economic growth.
5] Values (level of control), behavior (consumption rate), governance (public funding) and hydrology (water quantity and flooding) influence the type and amount of infrastructure in the region (e.g. Alternative energy, flood walls).
6] The economy and infrastructure influence one another. Economic growth can spur demand for and investment in regional infrastructure. Infrastructure projects can spur economic growth, both directly (construction and management jobs overseeing projects) and indirectly (competitive advantage for relocation).
7] Economy, through growth in job availability influences migration rates. Industry sectors also influence educational attainment, wealth and ethnicity. Demography is also influenced by human behavior (E.G. natural increase)
8] The number of households and number of jobs influences the amount and type of development.
9] Development and infrastructure influence each other. The more development, the more infrastructure needed to support the development; meanwhile, infrastructure growth is a catalyst for new development. The relationship between development and infrastructure is secondary to influence of economy and governance (directing available funding and control) on development and infrastructure.
10] Knowledge, in terms of innovation stems from global changes and drives 10a) economic, infrastructure and behavioral changes, 10b) governance and values influence outreach while 10c) demography (educational attainment) influences the use of science.
11] Biophysical template, 11a) including soil characteristics and seismic events influence infrastructure and development patterns. Modifications to the biophysical template in terms of 11b) chemical inputs and landscape movement are driven by the built environment (resource management, development and infrastructure).
12] Resource management is largely influenced by the 12a) capacity of the land (biophysical template, ecosystem and hydrology), 12b) ability to make a profit (economy and development values) and 12c) human behavior in terms of relationship to nature.
13] Ecosystems have largely been described outcomes of other drivers, but they do feedback to influence the drivers as well. 13a) ecosystems are most directly influenced by the natural environment (hydrology, climate and biophysical template) while 13b) human influence of the natural environment through alterations to the built environment (infrastructure, resource management and development) have caused notable changes to ecosystem health.

Table 2: Comparison of Indicator Trajectories across scenarios

Legend: ↗ Increase ↑ Fast Increase ↘ Decrease ↓ Fast Decrease ↔ Stable **?** Uncertain / No clear trend **NA** Not Available / Applicable

DF	Dimension: Indicator	Trajectory	Spatial Extent	Temporal Extent	scenario 1	scenario 2	scenario 3	scenario 4
Selected Drivers	Magnitude of temperature: change in degC	↗	PNW	1900-present	↗	↗	↔	↔
	Magnitude of precipitation: change in annual precipitation (inches)	?	PNW	1900-present	↗	↗	↔	↔
	Extreme temperature events: frequency and intensity of heat waves	↗	PNW	1970-present	↗	↗	↔	↔
	Extreme precipitation events: frequency + intensity of consequtive dry and wet days	?	PNW	1970-present	↗	↗	↔	↔
	Relationship to Society + Nature: mastery vs. harmony	Mastery	National	NA	Mastery	Harmony	Mastery	Harmony
Climate	Pace: rate of climate chage	↔	PNW	1900-present	↑	↗	↔	↔
	Global change: cost of damages linked to climate change	↗	global	NA	↗	↗	↗	↔
	snowpack: average snow-water equivalent on April 1st	↘	PNW	1935-2010	↓	↘	↔	↔
Human Values	Identification: autonomy vs. traditionalism	Autonomy	National	NA	traditionalism	autonomy	autonomy	traditionalism
	Organization: heirarchy vs. egalitarianism	NA	NA	NA	Heirarchy	Egalitarianism	Hierarchy	Egalitarianism
	Interests: individual vs. collectivist	Individualism	National	NA	individualism	individualism	individualism	collectivism
	Risk Perception: risk averse vs. first adaptor	NA	NA	NA	risk averse	first adaptors	first adaptors	risk averse
Demography	Population growth: rate of population change per decade	↗	Basin	1960-2010	↘	↗	↑	↔
	educational attainment: % with BS or higher	↗	Basin	1960-2000	↘	↗	↗	↗
	ethnicity: % white; other race	↓	Basin	1960-2010	↗	↘	↓	↘
	age structure: % of population in age brackets	↗ [25-44]	Basin + County	1960-2010	↗ [65+]	↔	↑ [25-44]	↗
	household structure: people per HH + % married	↓	Basin	1960-2010	↗	?	↘	
	public health: percent healthy days	NA	NA	NA	↓	↔	↔	↗
Behavior	consumer expenditures: % expenditures on food, housing & transportation	↘	Seattle-Everett Metro Area	1988-2009	↗	↗	↘	?
	relationship to nature: 'myths of nature'	?	NA	NA	nature capricious	nature resilient	nature benign	nature ephemeral
	investments: NA	NA	NA	NA	security	adaptation	economic growth	social + env.
Economy	Dominance of industry sectors: fastest growing sector(s) by % of employee	professional	Basin	1960-2000	service + operations	professional	professional	diverse
	Market: consumer price index	↗	Seattle-Everett	1960-2010	↑	↗	↗	↔
	labor: % unemployed	?	Basin + County	1960-2000	↗	↘	↓	↔
	wealth: average wages; gini index	↗	County	1969-2009	↗ / ↘	↗	↑	↔
	economic growth: total personal income as proxy for GDP	↗/ ↑	County	1969-2009	↘	↗	↑	↔

DF	Dimension: Indicator	Trajectory	Spatial Extent	Temporal Extent	scenario 1	scenario 2	scenario 3	scenario 4
Selected Drivers	Magnitude of temperature: change in degC	↗	PNW	1900-present	↗	↗	↔	↔
	Magnitude of precipitation: change in annual precipitation (inches)	?	PNW	1900-present	↗	↗	↔	↔
	Extreme temperature events: frequency and intensity of heat waves	↗	PNW	1970-present	↗	↗	↔	↔
	Extreme precipitation events: frequency + intensity of consequtive dry and wet days	?	PNW	1970-present	↗	↗	↔	↔
	Relationship to Society + Nature: mastery vs. harmony	Mastery	National	NA	Mastery	Harmony	Mastery	Harmony
Governance	scale of political strength: budget per regulatory agency	↗	NA	NA	state / federal	county / region	municipality	local
	planning and regulation: # of regulations + initiatives passed	NA	NA	NA	↗	↗	↓	↘
	service provision: NA	NA	NA	NA	poor	public, good	private, good	equitable
Social Institutions	community: % in urban vs. rural development	↑	Basin	1960-2000	↔	↗	↑	↘
	work centrality: importance of work relative to family and leisure	↗	NA	NA	↔	↔	↗	↓
	strength and influence of tribes: NA	↗	NA	NA	?	?	?	?
	global cooperation (with region): NA	?	global	NA	↘	↗	↑	↘ then ↗
	global stability: NA	?	global	NA	↘ then ↓	↘ than ↗	↘ and ↗	↔
	political will: voter turnout by county	?	County	NA	↘	↗	↔	↑
	organization: # of ngo / npo	NA	NA	NA	↘	↗	↔	↑
Knowledge	investment in innovation: $s spent in R+D	↗	US	1953-2008	↗	↗	↑	↘
	access to information: NA	NA	NA	NA	↔	↗	↗	↔
	specialization in science and technology: % of degrees in science & engineering	NA	NA	NA	↔	↗	↗	↔
Development Pattern	character: people per built area	?	Basin	1960-2000	↘	↗	↓	↔
	shape / centrality of development: aggregation index by year built	↘	NA	NA	↘	↗	↘	↘
	land use dominance: % change in LU	NA	NA	NA	residential	urban clusters	industrial	resource
	residential development: residential building permits	↗	Basin / WA	1988-2009	↘	↗	↑	↔
	real estate: housing values	↗	Basin	1960-2000	↘ / ↗	↗	↑	↘
	municipalities: percent incorporated	↗	Basin	1960-2010	↘	↗	↑	↘

DF	Dimension: Indicator	Trajectory	Spatial Extent	Temporal Extent	scenario 1	scenario 2	scenario 3	scenario 4
Selected Drivers	Magnitude of temperature: change in degC	↗	PNW	1900-present	↗	↗	↔	↔
	Magnitude of precipitation: change in annual precipitation (inches)	?	PNW	1900-present	↗	↗	↔	↔
	Extreme temperature events: frequency and intensity of heat waves	↗	PNW	1970-present	↗	↗	↔	↔
	Extreme precipitation events: frequency + intensity of consequtive dry and wet days	?	PNW	1970-present	↗	↗	↔	↔
	Relationship to Society + Nature: mastery vs. harmony	Mastery	National	NA	Mastery	Harmony	Mastery	Harmony
Infrastructure	energy source: % total consumption by source	↑ gas | ↔	WA	1970-2005	↑ gas | ↘	↘ gas | ↘	↑ gas | ↗	↓ gas | ↘
	energy conservation: Btus per capita	↘	WA	1970-2005	↔	↘	↗	↘
	waste generated: tons disposed per capita	↘	King County	1977-2010	↔	↘	↗	↓
	water consumed: total water consumed by user	↗	NA	NA	↘	↘	↗	↓
	water povision: % of residences on well vs. city water	↘	NA	NA	↗	↘	↘	↔
	transportation: time and distance traveled	↗	Central PS	1960-2006	↗	↔	?	↘
	waterway alteration: dams and stream permits for bank + flow control	NA	County	1989-2010	↑	↔	↔	↘
Resource Management	agriculture: acres by type	↘	County	1974-2009	↘	↔	↗	↗
	forestry: timber tax revenue as % of County personal income	↓	County	1978-2009	↘	↔	↗	↗
	recreation: acres of recreation lands (parks, wilderness)	↗	NA	NA	↘	↗	↗	↗
Biophysical Template	soils and minerals: % of soil built over by year	↘	Basin	1960-2000	↘	↔	↘	↗
	landscape movement: elevation of development by year built	↗	Basin	1960-2000	↑	↔	↗	↗
	toxins and chemicals: application of fertilizers, # of livestock, impervious surfaces, traffic counts, industry	↘	County / WA	1974-2009	↗	↔	↗	↓
Hydrology	flooding: frequency and stage	↗	Basin	1960-2010	↑	↗	↗	↔
	streamflow: selected river (cfs)	↗	Basin	1960-2010	↑	↗	↗	↔
	water quality: NA	NA	NA	NA	↓	↘	↘	↗
	water quantity: NA	NA	NA	NA	↘	↘	↘	↔
Ecosystems	biodiversity: # of Endangered and Threatened species per year	↗	County	1967-2006	↑	↔	↑	↘
	forest habitat: acres of forested land	↘	NA	NA	↘	↔	↓	↗
	invasives: NA	↑	NA	NA	↑	↗	↑	↔
	salmon and stream habitat: salmon escapement for WRIA7 species	?	Basin	1965-2005	↓	↘	↘	↗

Table 3: Indicator Trajectory Decision Process			
Selected Drivers	Magnitude of temperature: change in degC	Knowledge	investment in innovation: $s spent in R+D
	Magnitude of precipitation: change in annual precipitation (inches)		access to information: NA
	Extreme temperature events: frequency and intensity of heat waves		specialization in science and technology: % of degrees in science & engineering
	Extreme precipitation events: frequency + intensity of consequtive dry and wet days	Development Pattern	character: people per built area
	Relationship to Society + Nature: mastery vs. harmony		shape / centrality of development: aggregation index by year built
Climate	Pace: rate of climate chage		land use dominance: % change in LU
	Global change: cost of damages linked to climate change		residential development: residential building permits
	snowpack: average snow-water equivalent on April 1st		real estate: housing values
Human Values	Identification: autonomy vs. traditionalism		municipalities: percent incorporated
	Organization: heirarchy vs. egalitarianism	Infrastructure	energy source: % total consumption by source
	Interests: individual vs. collectivist		energy conservation: Btus per capita
	Risk Perception: risk averse vs. first adaptor		waste generated: tons disposed per capita
Demography	Population growth: rate of population change per decade		water consumed: total water consumed by user
	educational attainment: % with BS or higher		water povision: % of residences on well vs. city water
	ethnicity: % white; other race		transportation: time and distance traveled
	age structure: % of population in age brackets		waterway alteration: dams and stream permits for bank + flow control
	household structure: people per HH + % married	Resource Management	agriculture: acres by type
	public health: percent healthy days		forestry: timber tax revenue as % of County personal income
Behavior	consumer expenditures: % expenditures on food, housing & transportation		recreation: acres of recreation lands (parks, wilderness)
	relationship to nature: 'myths of nature'	Biophysical Template	soils and minerals: % of soil built over by year
	investments: NA		landscape movement: elevation of development by year built
Economy	Dominance of industry sectors: fastest growing sector(s) by % of employee		toxins and chemicals: application of fertilizers, # of livestock, impervious surfaces, traffic counts, industry
	Market: consumer price index	Hydrology	flooding: frequency and stage
	labor: % unemployed		streamflow: selected river (cfs)
	wealth: average wages; gini index		water quality: NA
	economic growth: total personal income as proxy for GDP		water quantity: NA
Governance	scale of political strength: budget per regulatory agency	Ecosystems	biodiversity: # of Endangered and Threatened species per year
	planning and regulation: # of regulations + initiatives passed		forest habitat: acres of forested land
	service provision: NA		invasives: NA
Social Institutions	community: % in urban vs. rural development		salmon and stream habitat: salmon escapement for WRIA7 species
	work centrality: importance of work relative to family and leisure		
	strength and influence of tribes: NA		**Legend:**
	global cooperation (with region): NA		**Expert selected driving force variables**
	global stability: NA		**Primary relationships**
	political will: voter turnout by county		Secondary relationships
	organization: # of ngo / npo		external selections (not impact)

Summary of Selected Predictive Models

Model & System Modeled	Model Type	Inputs and Outputs	Scales
LCCM: land cover change (land cover and landscape pattern)	Multinomial logit framework	**Inputs:** Current & historic land cover, adjacent land cover, land use, transportation infrastructure, topography, critical areas (steep slopes, wetlands, etc), spatial contagion of development **Outputs:** land cover change, probability of transition	**Time:** 3 year intervals **Space:** 30 by 30 m pixel across the Central Puget Sound
UrbanSim: Urban development (household, employment + workplace locations, real estate prices, real estate development, activity-based travel	Multinomial choice, multiple regression	**Inputs:** parcels, buildings, natural amenities, accessibilities, employment, development restrictions, transportation, regional economic forecasts **Outputs:** Location of households and employment, real estate prices, location, type and density of the built environment (dwelling units)	**Time:** Annual, daily for activity-based travel **Space:** buildings and parcels, travel network
WRF-CCSM3: down-scaled climate predictions (atmosphere and land surface)	Numerical simulation	**Inputs:** global climate simulations, topography, land cover **Outputs:** Meteorological fields (temperature, precipitation, wind, soil temperature, snow cover, soil radiation)	**Time:** 6 hour intervals **Space:** ~20 km grid across western US
WRF-ECHAM5: down-scaled climate predictions (atmosphere and land surface)	Numerical simulation	**Inputs:** global climate simulations, topography, land cover **Outputs:** Meteorological fields	**Time:** 6 hour intervals **Space:** ~36 km grid across continental US
Shiraz: fish habitat and salmon lifecycle (Chinook)	Stochastic simulation	**Inputs:** stream temperature, discharge, fine sediment, habitat types, forest cover, impervious cover, road density, precipitation, survival capacity, hatchery, harvest **Outputs:** Salmon population attributes: abundance, productivity, spatial structure, and life-history diversity	**Time:** annual timestep **Space:** user specified, often for sub-basins
Potential Vegetation Model: potential vegetation zone	Deterministic boundary equation model	**Inputs:** total annual precipitation at sea level, mean annual temperature at sea level, fog effect, cold air drainage effect, topographic moisture, temperature lapse rate, aspect, potential shortwave radiation **Outputs:** location of 15-20 potential vegetation zones	**Time:** none **Space:** 90 m pixel across WA state
HSPF: local watershed hydrology and water quality	Empirically derived, deterministic discrete space/time	**Inputs:** rainfall and other meteorologic records (such as solar radiation) and land surface characteristics (vegetation cover, soil type) **Outputs:** hydrologic components (soil moisture, surface runoff, evapotranspiration), flood statistics (stream discharge, low flows), water quality	**Time:** subdaily **Space:** spatially lumped into ~2 km^2 subcatchments
DHSVM: regional hydrology	Deterministic discrete space/time mechanistic, physical (hydrologic) process[1]	**Inputs:** meteorologic records and land surface characteristics **Outputs:** hydrologic components and flood statistics	**Time:** subdaily intervals (1-3 hrs depending on size of basin) **Space:** 300 – 200 m resolution across Puget Sound basin
VIC: large scale hydrology	Deterministic discrete space/time mechanistic, physical (hydrologic) process[1]	**Inputs:** meteorologic records and land surface characteristics **Outputs:** meteorologic drivers (humidity, solar radiation), hydrologic components and flood statistics	**Time:** daily (snow is at hourly intervals) **Space:** 1/16 degree (~32 km^2)
Puget Sound Watershed Characterization Project: water movement	Deterministic qualitative model	**Inputs:** land cover, soil types, discharge areas, habitat inventory, rain on snow areas **Outputs:** landscape indicators based of delivery and controls of water movement, surface storage, subsurface movement and recharge and discharge	**Time:** none **Space:** flexible, to a ~1 mi^2
Ecopath with Ecosim (EwE): a mass balance model for evaluating food web structure and community scale indicators	Trophodynamic mass balance simulation	**Inputs:** functional groups, foodweb relationships, fishing, reproduction, mortality and habitat types **Outputs:** biomass allocation, functional group diversity, energy flow and mortality	**Time:** monthly timesteps **Space:** not explicitly modeled, represented with functional diet rules
Atlantis: biophysical ecosystem model	Spatially discrete deterministic biogeochemical whole of ecosystem	**Inputs:** functional groups, foodweb relationships, abiotic features (temperature, circulation, nutrients, dissolved oxygen), spatial dynamics, species-habitat interactions, life history features, management policies **Outputs:**	**Time:** 12 hour timesteps **Space:** user specified

[1] Water and energy balance

Synthesis

Integrated Model Workshop Nov. 3, 2011
Synthesis of Findings. UERL.

Who was there and what did we do?

10 model experts and scenario developers attended the workshop on November, 3rd (Table 1). We divided up into three teams of 3-4 people. For exercises 1 and 2, teams were asked to rank pre-selected dimensions of driving forces and indicators of ecosystem services (respectively) based on how compelling they are (important to telling a good story), if they are a good measure (relevant to the focal issue[1], an accurate measure and informative of the condition), if data is available (for the Snohomish Basin and for at least the past 10 years) and they can be modeled (as either an input or output in one or more of the selected models).

Major Findings (Table 2 summary of linkages; Figures 1-3 Team Blueprints)

Major inputs external to the integrated model include global climate, socio-political and economic drivers. Within the integrated model frameworks experts agreed that WRF (regional climate) and UrbanSim (urban development) represent overarching inputs (top-level) while SHISRAZ and EcoPath represent overall outputs (bottom-level). Hydrology models, LCCM (Landcover change) and Potential Vegetation Model had varied representation, however they were generally incorporated the highest number of relationships (both as inputs into other models and as feedbacks). The PS Watershed Characterization Model appeared to be poorly represented or understood as its representations was highly inconsistent across the three teams.

The Integrated Model would need to represent the differences across the four scenarios by varying the boundary conditions associated dimensions of driving forces such as demography, economy, governance, and infrastructure. The list of over 60 dimensions was reduced to ~26 (Table 3). It was clear from the exercise outcomes that social dimensions including human values, behavior, governance and social institutions required substantially better proxies in terms of 1) clearer definition of what would be measured 2) clearer representation of expected relationship to scenario logics and 3) detailed information about what is quantitatively available.

Change in future functioning of Ecosystem Services would be represented by the outcome of the Integrated Model specified by indicators for water quality and quantity, carbon fluxes and storage and species and habitat diversity. Table 4 includes the list of the highest ranking indicators, in terms of availability, compelling, appropriate measures that have been previously linked to predictive models. It was clear from looking over the response rate and agreement level (variance) in the team's ranking that the workshop included good representation of water quality and quantity expertise, but poor representation in the other measures, especially measurement of carbon fluxes and stocks.

[1] The focal issue is: To maintain ecosystem services (around water quality + quantity, carbon stocks and fluxes and species and habitat diversity) in the Snohomish Basin out to 2060

Table 1: Workshop Attendees

name	agency
Bartz, Krista	NOAA's Northwest Fisheries Science Center, Conservation Biology Division
Beyers, William	University of Washington Department of Geography
DeGasperi, Curtis	King County Water and Land Resources Division
Hamlet, Alan	University of Washington Civil Engineering
Harvey, Chris	NOAA Fisheries
Lettenmaier, Dennis	University of Washington Civil Engineering
Salathe, Eric	Climate Impacts Group, University of Washington, Department of Atmospheric Sciences
Schmidt , Rowan	Earth Economics
Simonson, Mark	Puget Sound Regional Council
Stanley, Stephen	Washington Department of Ecology

Table 2: Represented Linkages between Selected Models

Arrow from \ Arrow to	Climate Change	Hydrology	LCCM	UrbanSim	Vegetation	PS Characterization	EcoPath	Shiraz
Climate Change		H	L	M	M	L	H	H
Hydrology	N		L	M	M	L	L	L
LCCM	L	L		N	N	M	H	M
UrbanSim	M	M	H		N	N	H	H
Vegetation	N	M	M	N		N	H	H
PS Characterization	N	N	N	M	N		M	L
EcoPath	N	N	N	M	N	N		M
Shiraz	N	N	N	N	N	L	M	

H=all teams represented linkages. M=2 out of 3 teams. L=1 team. N=no team.
diagnol lines= feedback needed. Dots = indirect linkages
*Only 2 teams represented UrbanSim and 2 (different) team represented Vegetation.

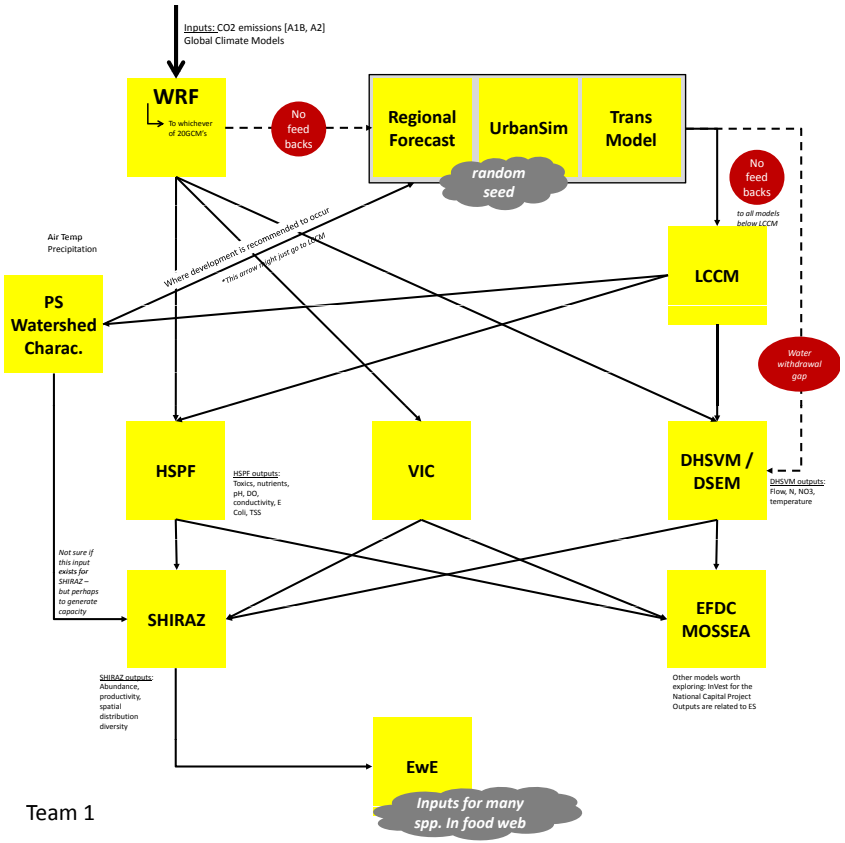
Table 4. Compelling, Appropriate, Available Indicators of Ecosystem Services

Ecosystem Service	Indicator
Water Quantity	Stream Variability: Frequency and intensity of peak and drought levels
	Available Snowpack: SWE April 1st
Water Quality	Fecal Coliform
	*pesticides and water temperature were rated high and selected by many, but reflected higher levels of disagreement across participants
Species Diversity	Salmon escapement per species
Habitat Diversity	Mean patch Size (total forest cover)
	Land use/cover change: Distribution/extent of land cover transition
	Habitat connectivity: Contagion Index / Aggregation Index
Carbon Fluxes	CO2 Emissions: # of Vehicles / Miles driven
Carbon Stocks	Forest stocks: Acres of forestland by urban-rural gradient

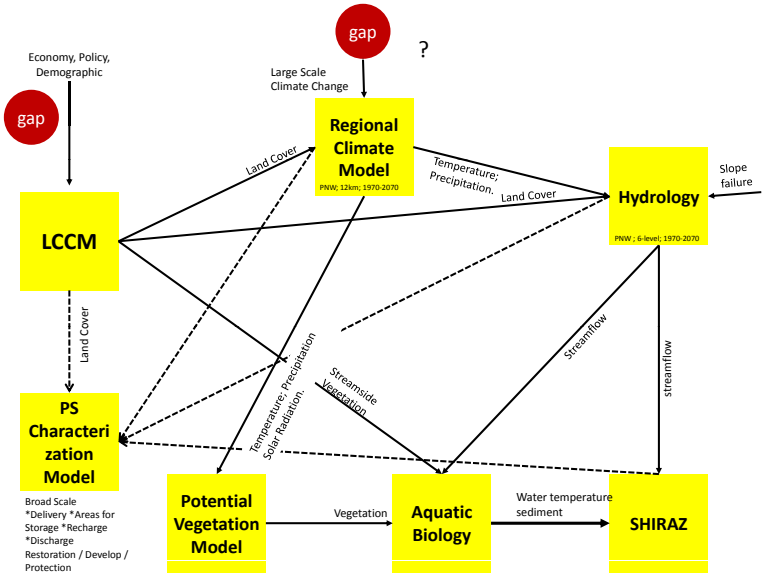
Table 3: Compelling, Appropriate and Available Driving Force Dimensions

Driving Force	Dimension
Climate Change	*Almost all dimensions fit the above criteria except the magnitude of precipitation, represented as the least compelling.
	Magnitude Of Temperature: Average annual surface air temperature for Puget Sound in Deg C
	Extreme Temperature Events: Frequency / Intensity Of Heat Waves
	Extreme Precipitation Events: Frequency + Intensity Of Consecutive Dry And Wet Days
	Rate Of Climate Change: Increase in Annual Temperature / Decade
Human Values	*none of the dimensions fit the above criteria. This may be due to a lack of definitions / available measures.
Demography	Population Growth: Rate + Size of Population Growth Per Decade
	Age Structure: Population Pyramid (Basin and Counties)
Behavior	Consumer Expenditures: % Expenditures On Food, Housing & Transportation
	* CE was the second most popular dimension, but some mentioned it should go under Economy
Economy	Total Income
	Labor: % Unemployed
	Average Wages; Gini Index
Governance	*none fit criteria. This may be due to a lack of definitions / available measures.
Social Institutions	Community: % In Urban Vs. Rural Development
Knowledge	Investment In Innovation: $s Spent In R+D
Development	People Per Built Area
	Residential Building Permits
Infrastructure	*Almost all dimensions fit the above criteria except water provision and waterway alteration. [Energy Source
	Energy Source: % Total Consumption By Source
	Energy Conservation: Btus Per Capita
	Water Consumed: Total Water Consumed By User
	Transportation: Time And Distance Traveled
Resource Management	Acres Of Recreation Lands (Parks, Wildemess)
Biophysical Template	Toxins And Chemicals: Application Of Fertilizers, # Of Livestock, Impervious Surfaces, Traffic Counts, Industry
	Elevation Of Development By Year Built
Hydrology	Flooding: Frequency And Stage
	Water Quantity: Snowpack SWE April 1st
Ecosystems	Acres Of Forested Land
	Salmon Escapement For WRIA7 Species

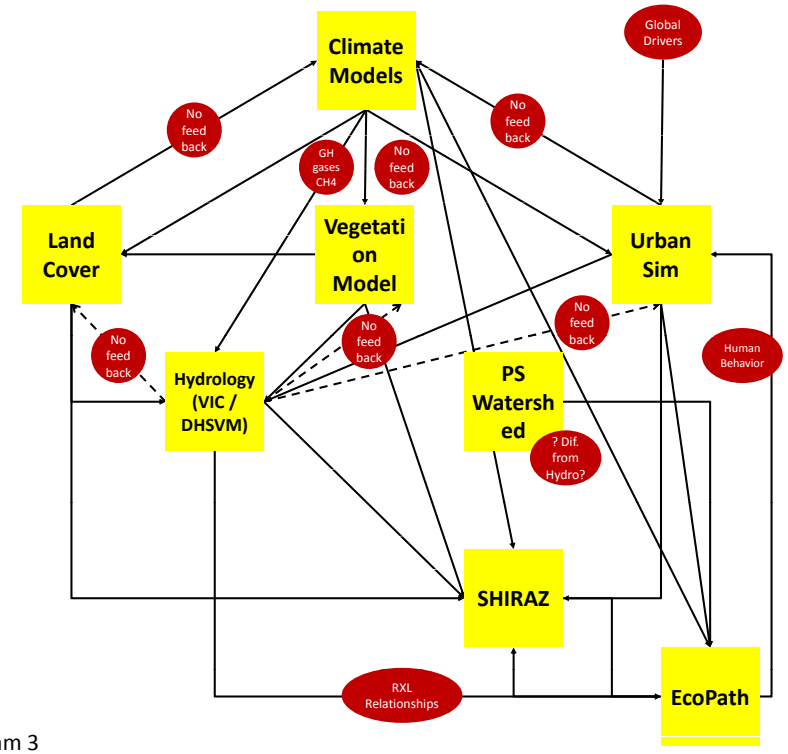
* dimensions that can be represented by current models are in gray


Inputs: CO2 emissions [A1B, A2]
Global Climate Models
WRF
To whichever of 20GCM's
No feed backs
Regional Forecast
UrbanSim
Trans Model
random seed
No feed backs
to all models below LCCM
Air Temp
Precipitation
Where development is recommended to occur
*This arrow might just go to land
LCCM
PS Watershed Charac.
Water withdrawal gap
HSPF
HSPF outputs: Toxics, nutrients, pH, DO, conductivity, E Coli, TSS
VIC
DHSVM / DSEM
DHSVM outputs: Flow, N, NO3, temperature
Not sure if this input exists for SHIRAZ – but perhaps to generate capacity
SHIRAZ
EFDC MOSSEA
SHIRAZ outputs: Abundance, productivity, spatial distribution diversity
Other models worth exploring: InVest for the National Capital Project Outputs are related to ES
EwE
Inputs for many spp. In food web

Team 1


gap
?
Economy, Policy, Demographic
gap
Large Scale Climate Change
Regional Climate Model
PNW; 12km; 1970-2070
Land Cover
Temperature; Precipitation.
Land Cover
Hydrology
PNW ; 6-level; 1970-2070
Slope failure
LCCM
Land Cover
Streamflow
streamflow
Temperature; Precipitation
Solar Radiation
Streamside Vegetation
PS Characterization Model
Broad Scale
*Delivery *Areas for Storage *Recharge
*Discharge
Restoration / Develop / Protection
Potential Vegetation Model
Vegetation
Aquatic Biology
Water temperature
sediment
SHIRAZ

Team 2



Team 3

Integrated Model Workshop Nov. 3, 2011
Synthesis of Findings. UERL.

Detailed Methodology of Synthesis:

For exercises 1 and 2, teams were asked to rank pre-selected dimensions of driving forces and indicators of ecosystem services (respectively) based on how compelling they are (important to telling a good story), if they are a good measure (relevant to the focal issue[2], an accurate measure and informative of the condition), if data is available (for the Snohomish Basin and for at least the past 10 years) and they can be modeled (as either an input or output in one or more of the selected models). Not all teams integrated their input into 1 document, so available individual responses were used in this synthesis.

Overall, we synthesized 7 worksheets for exercise 1 and 5 worksheets for exercise 2. Scores were normalized to a 5pt score[3]. Generally a score greater than or equal to 4 were identified as a high score. Response rate reflected the number of worksheets (count) that had any response (whether high or low). The assumption was that a high response rate reflected a presence of knowledge or expertise, while a low response rate reflected a gap in represented knowledge. Generally, a response rate of 2 or lower represented a gap. Divergence was calculated as the variance in scoring between the submitted worksheets. The assumption was that a high variance reflected disagreement across represented experts. Variance was only considered when response rate was 3 or higher.

In exercise 3, teams were asked to develop an integrated model blueprint and then run a hypothetical test case for each scenario, exploring changes in the trajectories of selected dimensions and indicators from exercise 1 and 2. All three teams developed a paper blueprint. Trajectories for the selected dimensions and indicators were too varied to integrate, but a few highlights are synthesized in the details below.

DETAILS: EXERCISE 1: DIMENSIONS OF DRIVING FORCES

1. **The 25 most compelling, appropriate measures that we have data for were:**
   - Climate change *(note: all selected except magnitude of precipitation which was not considered 'compelling)*
     - Magnitude Of Temperature: Average annual surface air temperature for Puget Sound in Deg C
     - Extreme Temperature Events: Frequency / Intensity Of Heat Waves
     - Extreme Precipitation Events: Frequency + Intensity Of Consecutive Dry And Wet Days
     - Rate Of Climate Change: Increase in Annual Temperature / Decade
     - Global Change: Cost Of Damages Linked To Climate Change
     - Snowpack: Average Snow-Water Equivalent On April 1St
   - Human Values (note: none selected. Worst ratings for data availability)
   - Demography: (note: population growth scored highest of all dimensions from all driving forces; while available race and educational attainment were considered poor measures).
     - Population Growth: Rate + Size of Population Growth Per Decade

[2] The focal issue is: To maintain ecosystem services (around water quality + quantity, carbon stocks and fluxes and species and habitat diversity) in the Snohomish Basin out to 2060
[3] X=4, 0=1 and 1-3 scale was converted to 1=1, 2=3 and 3=5. Scoring was calculated by averaging out the worksheets

- Age Structure: Population Pyramid (Basin and Counties).
- Household Structure: People Per Hh + % Married

- Behavior: (note: CE was the second most popular dimension, but some mentioned it should go under Economy).
- Economy:
  - Labor: % Unemployed
  - Wealth: Average Wages; GINI Index
  - Economic Growth: Total Personal Income As Proxy For GDP
- Governance (note: none selected, high disagreement among participants on what is compelling and good)
- Social Institutions: % in urban/rural development
- Knowledge: Investment in Research (vs. Development)
- Development Patterns: (note: while generally considered available, these dimensions were generally not highlighted as the most compelling or good measures).
  - People per Impervious Area
  - Residential Building Permits
- Infrastructure (note: these were generally seen as compelling)
  - Energy Source: % Total Consumption By Source
  - Energy Conservation: Btus Per Capita
  - Water Consumed: Total Water Consumed By User
  - Transportation: Time And Distance Traveled
- Resource Management: Acres of recreation (seen as most compelling and good measure)
- Biophysical Template: (Note: not seen as compelling nor available)
- Hydrology:
  - Flooding
  - Water Quantity
- Ecosystems:
  - Acres of Forested Lands
  - Salmon Escapement

2. The worst (least compelling, appropriate and available) dimensions are:

- In general, the dimensions that ranked lowest were ones that were not specified. Either characterized as NA (e.g. service provision or investments) or with a title that is not self-explanatory (e.g. 'myths of nature' or work centrality'). These indicators ranked low because of lack of data availability (except investments and number of NGOs that were considered poor measures).

3. The most divergent perspective on dimensions[4] were:

[4] Divergence was calculated as the variance in response rate between the submitted worksheets.

- Climate change and social institutions (including governance) reflected the most divergent perspectives overall.
- Human Values had the most divergent perspective on available data

4. Dimensions that represented knowledge and gaps[5] were:

- Highest response rate (whether high or low scoring) was for climate, infrastructure, and hydrology.
- Poorest response rate was social institutions
- Fair-to-poor ratings for economy, human values, knowledge, ecosystems and development patterns

5. What additional dimensions were suggested:

- Climate Change: 1) Seasonal changes in temperature / precipitation
- snow line extent 2) explicit linkages to ecosystem services
- Human Values: 1) Business as usual vs. Integrated / Consensus 2) explicit linkages to economy, development and social
- Behavior: 1) transportation choices
- Economy: 1) Consumer Expenditures (moved from behavior) 2) investments (moved from behavior) 3) exports
- Governance: 1) ability to fund new improvements + maintenance 2) geographic scale (local vs. federal) 3) FEMA[6] 4) nested attributes of governance[7]
- Knowledge: 1) Investment in research vs. development[8] 2) Degree of separation between science and policy
- Development Pattern: 1) Growth Management act 2) Shoreline development and Armoring
- Infrastructure: 1) Transportation mode 2) Links to Growth Management Act 3) Wastewater Management
- Resource Management: 1) Open space and Conservation lands
- Biophysical Template: 1) Recharge (Wetlands and Floodplains)

4) Ecosystems: 1) Salmon life stage survival rates 2) fragmentation 3) Land and Water Interfaces 4) Terrestrial and Marine Interfaces

6. Which dimensions are uncertain / had question marks associated with them:

- Land Use Dominance: % Change In Lu
- Municipalities: Percent Incorporated
- Soils And Minerals: % Of Soil Built Over By Year

[5] Level of awareness and gaps were calculated based on the number (count) of responses. The assumption is, that if many experts responded (whether high or low) to a dimension/ indicator they are aware / knowledgeable of it. While if no responses occur, it reflects gap in represented knowledge.
[6] Unclear what was meant by this suggestions.
[7] It was noted that level of urbanization is not 'with their flow chart'. It was unclear what was meant by this.
[8] It was suggested to look at research versus development as opposed to the funds allocated to both together.

- Landscape Movement: Elevation Of Development By Year Built
- Toxins And Chemicals: Application Of Fertilizers, # Of Livestock, Impervious Surfaces, Traffic Counts, Industry

7. **Additional comments:**
   - A few dimensions were notes as 'outputs' (not inputs of the scenarios).
     - Global Change: Cost Of Damages Linked To Climate Change
     - Snowpack: Average Snow-Water Equivalent On April 1st
     - Age Structure: Population Pyramid (Basin and Counties).
     - Labor: % Unemployed

DETAILS: EXERCISE 2: ECOSYSTEM SERVICE INDICATORS

1. **Overall, the most compelling[9] indicators selected were:**
   - Forest stocks: Acres of forestland by urban-rural gradient [5]
   - CO2 Emissions: # of Vehicles / Miles driven [4.5]
   - Habitat connectivity: Contagion Index / Aggregation Index [4.5]
   - Pollution levels: Levels of exposure to PCB's, PBDE, Dioxins, Pesticide [4.5]
   - Stream Variability: Frequency and intensity of peak and drought levels
   - Available Snowpack: SWE April 1st
   - Pesticides + Toxins: Likelihood of Dieldrin in Fish
   - Pesticides + Toxins: Mercury levels
   - Acres of protected natural area: Distribution & extent of public & private lands amenable to biodiversity & NGO/trust lands for biodiversity
   - Dominance of habitat: Landscape diversity (Shannon landscape evenness index)
   - Disturbance Regimes: Occurrence/abundance of disturbance sensitive vs. tolerant vs. dependent bird species; Spatial extent of fire, insect outbreaks, floods & windthrows occurrence rates of floods; Occurrence rates of droughts
   - Land use/cover change: Distribution/extent of land cover transition
2. **The most agreed upon good high ranked indicators:**
   - High agreement generally reflected low response rates. But the three most responded to indicators that ranked high by all were:
     - Precipitation: Total depth (inches) per month
     - Bacteria: Fecal Coliform / E Coli
     - Nutrients: Conc. Of Nitrates and Phosphates
     - Available habitat: Mean patch Size (total forest cover)
3. **Which indicators reflected the most divergent views[10]:**

[9] Scores of 4.2 or higher and number of responses >4.
[10] Divergence was calculated as the variance in response rate between the submitted worksheets.

- Groundwater recharge (is it compelling? Appropriate?)
- Water quality index (is it appropriate?)
- Pollution levels (while considered compelling by majority, whether it's an appropriate and available measure was disagreed upon.

4. **Represented knowledge and gaps:**
   - There was a clear knowledge gap in terms of carbon fluxes and stocks. Out of 5 worksheets collected rarely did more than 1 worksheet reflect any response to these indicators[11].
5. **What additional ecosystem service indicators did you suggest?**
   - Frequency of fish kills
   - Nutrient Loadings
     - Pesticides linked to pollution levels of species diversity
6. **Which ecosystem service indicators are uncertain / had question marks associated with them:**
   - For species diversity it was uncertain whether indicators were specific to marine species.
   - Un-described questions marks appeared next to: Invasive species, Ecosystem Integrity: Soil organic matter (SOM), Plant productivity: Net primary productivity (NPP) and Chemistry: dissolved oxygen

DETAILS EXERCISE 3: MODEL INTEGRATION

Hierarchy *(assumption: highest placement: driver / lowest placement: outcomes)*

- Climate: driver
- LCCM: secondary driver
- EcoPath and Shiraz: outcomes
- Hydrology: generally a secondary driver alongside LCCM.
- PS Characterization: Uncertain placement
- Vegetation: Uncertain placement

Important linkages: *direct and indirect relationships and feedback*

- EcoPath and Shiraz were linked to by all models. They were linked to each other. The following models, in addition to being linked to Shiraz and Ecopath were linked to:
- Climate was linked to hydrology directly (by all).

[11] However, it should be noted that these were the last set, so perhaps participants simply ran out of time.

- Hydrology models were linked to other models by one team. Hydrological models were only differentiated by Team 1. Experts reflected varied linkages between the hydrology models and EcoPath. All showed a direct link to SHIRAZ.
- LCCM was linked to PS Characterization. It was linked to hydrology and climate change indirectly (by one team).
- UrbanSim was linked to Climate and land cover
- Vegetation was linked to hydrology and LCCM (by one team)
- PS Char. Was linked to UrbanSim (by one team)

Gaps and Uncertainty

- Feedbacks between UrbanSim, Regional Forecast and transportation model to 1) to WRF 2) to DHSVM as water withdrawls and 3) from all other models.
- Uncertainty around 'random seed' of urbanSim, Regional Forecast and transportation model
- Uncertainty of inputs for many species associated with EcoPath
- Large scale inputs into regional climate and economic, policy and demographic inputs for LCCM
- Feedback to climate from LCCM, Vegetation Model and UrbanSim
- Vegetation from Shiraz,
- Hydrology from UrbanSim and LandCover
- How human behavior influences UrbanSim (from EcoPath?)
- How global drivers influence climate (WRF)
- How greenhouse gases influence hydrology

Selected inputs

Looking at the **blueprints** *inputs* may include global climate inputs (emissions, temperature, and or precipitation) as well as economy, policy and demographic inputs (into LCCM).

Looking at exercise 1, the flowing dimensions were identified as **potential model inputs** (scoring 4 or above on average) that were also considered compelling, appropriate and available.

- Magnitude Of Temperature: Average annual surface air temperature for Puget Sound in Deg C
- Extreme Temperature Events: Frequency / Intensity Of Heat Waves
- Extreme Precipitation Events: Frequency + Intensity Of Consecutive Dry And Wet Days
- Rate Of Climate Change: Increase in Annual Temperature / Decade
- Population Growth: Rate + Size of Population Growth Per Decade
- Age Structure: Population Pyramid (Basin and Counties).
- Household Structure: People Per Hh + % Married
- Consumer Expenditures: % Expenditures On Food, Housing & Transportation
- Labor: % Unemployed

Integrated Model Workshop Nov. 3, 2011
Synthesis of Findings. UERL.

- Wealth: Average Wages; Gini Index
- Economic Growth: Total Personal Income As Proxy For Gdp
- Energy Source: % Total Consumption By Source
- Energy Conservation: Btus Per Capita
- Water Consumed: Total Water Consumed By User
- Transportation: Time And Distance Traveled
- Recreation: Acres Of Recreation Lands (Parks, Wilderness)
- Flooding: Frequency And Stage
- Water Quantity: Snowpack SWE April 1st
- Forest Habitat: Acres Of Forested Land
- Salmon And Stream Habitat: Salmon Escapement For WRIA7 Species

Inputs across scenarios: The majority of dimensions whose potential trajectory was described in Exercise 3 were shown to be hypothetically 'sensitive' to the scenarios. However, many were described by question marks including: export, population growth, educational attainment, consumption, land use, and infrastructure.

Selected outputs

Looking at the **blueprints** outputs may for water quantity may include flow from hydrology model outputs. Water quality may be comprised from various indicators from both hydrology models[12] and EcoPath. Species diversity in regards to salmon may come from Shiraz[13] while food web relationships may come from EcoPath. Broad estimations of Habitat diversity may stem from the Potential Vegetation Model and the Puget Sound Characterization Model. Forest biomass may come from LCCM (land cover),

Looking at exercise 2, the flowing ecosystem indicators were identified as **potentia**l **model outputs** (scoring 4 or above on average) that were also considered compelling, appropriate and available.

- Stream Variability: Frequency and intensity of peak and drought levels
- Available Snowpack: SWE April 1st
- Precipitation: Total depth (inches) per month
- Cost of Water Provision: $ / gallon (to consumer)
- Water Temperature: # of Exceedance of Water Temperature / year
- Bacteria: Fecal Coliform / E Coli
- Pesticides + Toxins: Likelihood of Dieldrin in Fish
- Pesticides + Toxins: Mercury levels
- Salmon: Salmon escapement per species
- Available habitat: Mean patch Size (total forest cover)
- Available habitat: Total area by vegetation type
- Acres of protected natural area: Distribution & extent of public & private lands amenable to biodiversity & NGO/trust lands for biodiversity
- Habitat connectivity: Contagion Index / Aggregation Index
- Phenological trend: Leaf-on/-off dates, Flowering dates, Timing of migration

[12] HSPF outputs: Toxics, nutrients, pH, DO, conductivity, E Coli, TSS and DHSVM outputs: Flow, N, NO3
[13] Abundance, productivity, spatial distribution, diversity

- Land use/cover change: Distribution/extent of land cover transition
- CO2 Emissions: # of Vehicles / Miles driven
- Forest stocks: Acres of forestland by urban-rural gradient

Outputs across scenarios: The majority of outputs whose potential trajectory was described in Exercise 3 were shown to be hypothetically 'sensitive' to the scenarios. During the discussion many questions came up on how predictable these changes are.

- Water Quality Index
- Stream flow (seasonal variability)
- Biodiversity: # threatened and endangered
- Salmon Escapement
- Richness
- Balance Eveness
- Invasives
- Pollution
- # Priority habitats listed
- Habitat Connectivity
- Acres Protected
- Snowpack
- Stream flow (seasonal variability)
- # impaired water bodies
- water temperature
- sediments / turbidity
- nutrients
- HABs
- streamflow / SWE / 7Q10
- Peak summer water temperature
- area/hydroperiod of existing wetlands

Scenario Tests

Date

1.2012

Location

Phone and online interview.

Objective

Targeted meetings with selected members of Science Team to test the validity of specific trajectories of each driving force

Attendance

20 phone and online interviews with Science Team members.

Materials

Participants were shared the draft scenarios packet (see under Materials of Integrated Model Workshop, pages A6.122-128)

Survey Instrument (pages A6.138-139 Note. Each interview was slightly different, included here was the interview for Drinking Water Trajectories)

Synthesis

Science team members provided detailed feedback on the draft scenarios, with specific recommendations on how to better represent the potential variability across the four scenarios with respect to their area of expertise. The synthesis of the interviews was directly incorporated into the revisions of the final scenarios and specific driving force and ecosystem service trajectories described in Appendices 3 and 4.

A Scenario overview

1 Did you have a chance to review the scenarios? Do you have any initial questions about them?

2 Before we discuss specific drinking water trajectories, I'd like to hear your perspective on the scenarios overall. How did you read the narratives and what, if anything, needs our further attention (e.g. not logical, not clear what we mean, etc).

a Pretend for a moment you were describing these scenarios to a colleague. Can you distinguish between the four scenarios in a sentence or two?

- Are there any inconsistencies in the narratives?
- Is there anything missing from the storylines that would help make the story more compelling? Logical?

b Focusing only on drinking water, how would you describe the differences across the scenarios?

- Are these the most divergent plausible outcomes for the region in 50 years? What, if anything, would you change (either to an individual storyline or to the suite of scenarios)?

B **In-field Trajectories:** The next series of questions will attempt to largely unpack your drinking water distinctions from the question above.

1 Defining Drinking Water

a Define drinking water? Why is it important?

b What are good measures to describe drinking water? Water quantity? (cost, variability...)

c How might drinking water change over the next 50 years? What are potential extremes? (try to discuss in terms of the aforementioned measures).

d Are there any publications that discuss future predictions for drinking water in the basin?

e What are the most important drivers governing drinking water?

f Which of the important drivers' trajectory is the most uncertain, looking over the next 50 years? (e.g. precipitation pattern, urban development?)

g When thinking about the Basin's future drinking water, we largely saw four drivers to consider: *demand, regulations, climate change and technology* (efficiencies). We'd like to walk through each one of these to explore their potential relationship to drinking water.

2 Before we do, are there any additional drivers or variables we need to consider?

3 **Demand:** we thought of demand as the amount of households and industry that are using the regions resources.

a What is the relationship between demand and drinking water currently?

b What are critical challenges looking over the next 50 years?

c Are you familiar with any projections in regards to demand?

d For households we are thinking about total population growth, household size and percent on exempt wells vs. centralized water.

- What do we need to consider when thinking about these future trajectories?
- What is the uncertainty around exempt wells in this region?
- What is the trajectory around centralized service?

e How much can we grow before demand exceeds supply?

f For industry we looked at both industry sectors (manufacturing vs. Service) and acres of Copland (agriculture).

- What is the relative importance of industry consumption in the basin? What do we need to consider?
- Based on your reading of the four scenarios, what is the relative change in withdrawls under each scenario?

4 **Regulation:** includes new regulations, e.g. salmon protection, exempt wells, stricter regulations, even loss of the watershed protection.

a What are potential changes to regulation influencing drinking water in the Basin?

b What are critical challenges looking over the next 50 years? Where does the uncertainty lie?

c Are there any forecasted trajectories for regulatory reform?

d Based on your reading of the four scenarios, what is the relative change in regulation that might be associated with each scenario?

5 **Climate change:** here we are largely thinking of snowmelt and precipitation variability.

a Are you familiar with any publications that provide quantitative predictions for SWE for the Basin in 2060 (or 2040, or 2080 for that matter)? Are you comfortable putting any numbers in the 'major' vs. 'minor' categories?

b Are you familiar with any publications that provide…precipitation variability? Are you comfortable putting any numbers down?

c Is there any other climate variable that will influence the long term availability of drinking water in the Basin?

d Are there any significant thresholds associated with precipitation variability and snowmelt in the Basin?

e The scenarios articulate major and minor climate change. What is the potential relationships between those overarching changes and specific changes to water availability?

6 **Technology:** we saw technology as largely increasing efficiencies of water consumption, from household appliances to industry (cooling) and agricultural (irrigation) use.

a Are there technologies that are currently being developed that you might influence the Basin' water usage over the next 50 years? Which ones?

b What is the current elasticity of water consumption? How much further might be able to extend conservation measures? How does this region rank nationally in terms of current efficiencies?

c In addition to efficiencies, it there any other technological advances that we should consider? Perhaps in terms of water quality? Gray water?

d Can you describe potential changes in drinking water under the four scenarios, based on how you read the scenarios?

C **Relationship to other variables**

1 **Drinking water** has important feedbacks to the system. Can you describe potential feedback across the scenarios? (i.e. spiritual benefits? Economic – quality of life? Public Health

2 What is the relationship between drinking water and provision of services?

D Anything else?

1 In addition to drinking water, what do you think is important for us to describe when distinguishing between the scenarios?

2 Is there anything else that you would like to add (e.g. reflecting on the scenarios?)

3 Do you have any questions for us?

Policy Workshop

Date

2.24.2012

Location

Graham Visitors Center. Seattle, WA.

Objective

The Policy Workshop focused on key challenges and opportunities for maintaining ecosystem function in the long term and identifying questions to facilitate robust decision making under uncertainty.

Attendance

24 basin stakeholders representing key actors influential in shaping the basin's future. See Appendix 1: Stakeholder Committee

Agenda

Exercise 1: Decisions under uncertainty

Plenary discussion 1: How to make better decisions

Team discussion 1: identfying critical decisions, actors and strategies

Team disucssion 2: risks, trade-offs and policy evaluation

Plenary discussion 2: Redefining the problem: what questions should we ask?

Materials

> Snohomish Basin Forecast package

A collection of forecasts characterizing potential changes within the Snohomish Basin and surrounding Puget Sound Region. The forecasts were synthesized by the UERL team into 8 overarching categories including: demography, economy, land cover change, climate, hydrology, sea level rise, water and energy supply and demand, and salmon.

see pages A6.142-145

> State of the Basin 2010 Package

A collection of current statistics and historical trends characterizing influential variables within the Snohomish Basin and surround Puget Sound Region. The graphs, maps and descriptions have been synthesized by the UERL team into seven overarching categories including: demography, economy, development, resource management, infrastructure, hydrology and ecosystems.

see pages A6.146-150

> Decision making under uncertainty exercise instructions and background data

Instructions for the exercise played during the Policy Workshop. Includes overview, list of eight pre-selected strategies and four indicators for assessing improvements. Background data includes narratives of the four scenarios and graphic illustration of potential future trajectories of key driving forces under the four scenarios.

see pages A6.151-158

> Presentation

see pages A6.159-168

Snohomish Basin Forecast Package

This package includes a collection of forecasts characterizing potential changes within the Snohomish Basin and surrounding Puget Sound Region. The forecasts have been synthesized by the UERL team into 8 overarching categories including: demography, economy, land cover change, climate, hydrology, sea level rise, water and energy supply and demand, and salmon. Included below are the references and links for each forecast . This package was developed to support the discussion at the Snohomish Basin Policy Workshop hosted by the UERL on February 24, 2012.

REFERENCES:

Demography:

- **Population Growth per Decade:** Puget Sound Regional Council. Puget Sound Economic and Demographic Forecast. 2006. http://psrc.org/data/forecasts/econdem/
- **Household Growth:** Ibid.
- **Ethnicity and Race in WA:** State Forecast 2000-2030. Office of Financial Management.
- **Age Structure in Washington State:** Ibid.

Economy:

- **Employment density:** Puget Sound Regional Council. Puget Sound Economic and Demographic Forecast. 2006. http://psrc.org/data/forecasts/econdem/
- **Total Number of Jobs in the Snohomish Basin:** Ibid
- **Employment Trends:** Ibid
- **Jobs per Sector in the Snohomish Basin:** Ibid

Land Cover Change:

- **Land Cover Change:** Land Cover Change Model for Central Puget Sound: Land Change Predictions to 2050. April 2010. Report prepared for Weyerhaeuser as part of the Puget Sound Development and Climate Change Project. Matt Marsik and Marina Alberti. Urban Ecology Research Laboratory. Department of Urban Design and Planning. University of Washington. http://www.urbaneco.washington.edu/R_LandcoverChange.html

Climate:

- **Temperature and Precipitation:** Implications of 21st Century Climate Change for the Hydrology of Washington State. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. 2009. Climate Impacts Group. http://cses.washington.edu/cig/res/ia/waccia.shtml
- **Seasonal Variability.** Ibid. p34-35
- **Extreme Events.** Ibid. p61-63

Hydrology:

- **Snowpack Loss:** Implications of 21st Century Climate Change for the Hydrology of Washington State. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. 2009. Climate Impacts Group. P95. http://cses.washington.edu/cig/res/ia/waccia.shtml.
- **Watershed Transitions.** Ibid. P9 and P234
- **Groundwater**: Water Supply Forum. Appendix X. Technical Memorandum #8: Impacts of Climate Change on Groundwater Resources: A Literature Review Prepared for: Climate Change Technical Committee. 12/13/2007.
- **Flow Statistics:** Implications of 21st Century Climate Change for the Hydrology of Washington State. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. 2009. Climate Impacts Group. p236-7. http://cses.washington.edu/cig/res/ia/waccia.shtml.

Sea Level Rise:

- **Habitat Vulnerability Assessment:** Sea-level Rise and Coastal Habitats in the Pacific Northwest: An Analysis for Puget Sound, Southwestern Washington, and Northwestern Oregon. July 2007. National Wildlife Federations. p47 and p49.
- **Transportation Vulnerability Assessment:** Transportation Vulnerability Assessment: Washington State Department of Transportation for submittal to the Federal Highway Administration. November 2011. Climate Impacts Vulnerability Assessment Report. p58-59

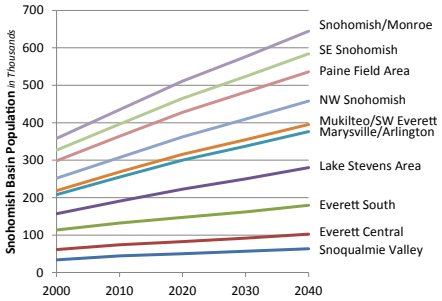
Water and Energy Supply and Demand

- **Water Supply and Demand:** Regional Water Supply Outlook. 2009. Water Supply Forum. http://www.watersupplyforum.org/home/outlook/
- **Energy Supply and Demand:** 2012 Washington State Energy Strategy. December 8, 2011. 2.3 Forecasting Energy Indicators Through 2035. p17-22. http://www.commerce.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=10206&MId=863&wversion=Staging
- **Climate impacts on Hydropower Supply and Climate impacts on energy demand due to changes in heating and cooling days**: Implications of 21st Century Climate Change for the Hydrology of Washington State. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate. 2009. Climate Impacts Group. http://cses.washington.edu/cig/res/ia/waccia.shtml

Salmon:

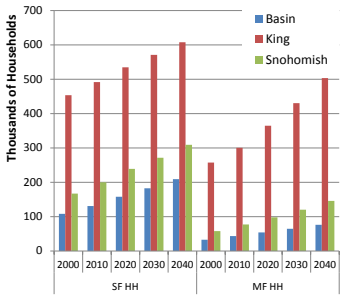
- **Air Mean Surface and Maximum:** Climate Impacts Group, University of Washington. June 2009. The Washington Climate Change Impacts Assessment Stream Temperature: Evaluating Washington's Future in a Changing Climate. p222 and p228.
- **Change in Mean Returning Chinook Spawners, 2000-2050:** J. Battin, K. Bartz, M. Ruckelshaus, H. Imaki, M. Wiley, E. Korb, and R. Palmer. NOAA Northwest Fisheries Science Center and University of Washington Civil and Environmental Engineering. Climate Impacts on Salmon Recovery in the Snohomish River Basin. http://cses.washington.edu/cig/res/ae/snohomish.shtml
- **Results of Hydrologic Model on Key Salmon Survival Limiting Factors:** Ibid.

Population Growth / Decade



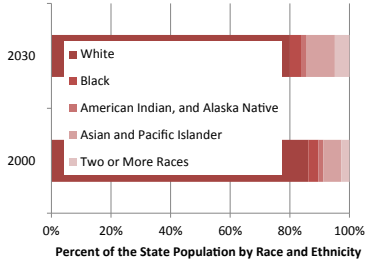
PSRC 2006 trends are based on declining rates of growth in both King and Snohomish Counties. While the growth rate was 9% in King and 21% in Snohomish County between 2000-2010, the rate is forecasted to decrease to 7.5% and 12%, respectively, between 2030-2040. If 2000-2040 trends were extended linearly to 2060, the Basin could be forecasted for an additional 350,000 people in the Basin (2010-2060)

Household Growth



In 2010, 25% of the Basin households lived in multiple-family units. By 2040, the percentage is forecasted to rise modestly to 26.7%. In King County, during the same time frame, the percentage of MF units is expected to rise from 38% to over 45%.

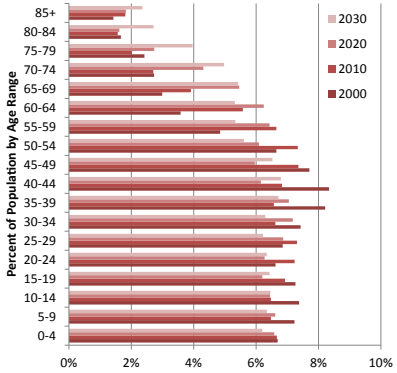
Ethnicity and Race in WA



In 2000, 7.5% percent of the State was of Hispanic Origin. By 2030, the percentage is forecasted to rise to 12.9%.

In 2000, the median age in the State was 35. By 2030, the median age is forecasted to rise to 39.
In 2000, 19% of the population was school aged (5-17). By 2030, only 16.7% of the population will be school aged. However, there will be over 300,000 more students in the system.
In 2000, 11% of the State population was of retirement age. By 2030, an additional 1 million people will be of retirement age (65+), one fifth of the total population.

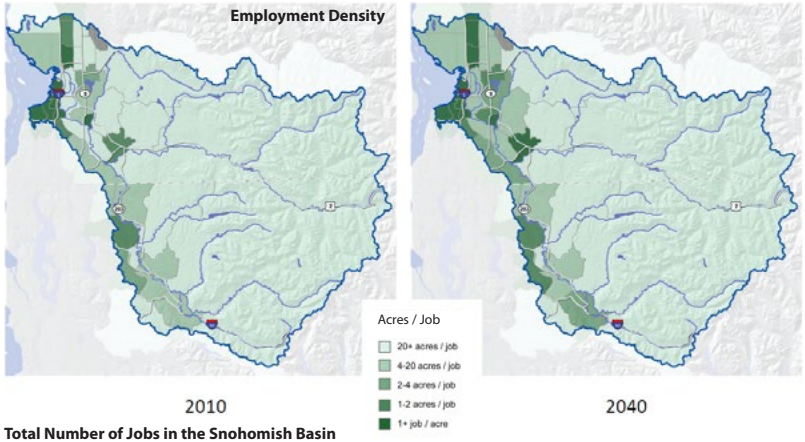
Age Structure in Washington State



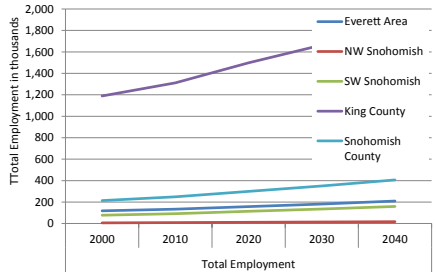
In 2010, the Basin's population represented ~6.5% of the State's population. If growth trends in the Basin remained fairly consistent with the State's growth trends, the Basin can be forecasted to grow by an additional 20,000 students and 65,000 retirees by 2030.

Demography *published data*

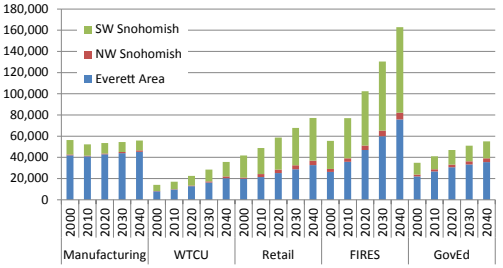
Employment Density



Total Number of Jobs in the Snohomish Basin



Jobs per Sector in the Snohomish Basin



Employment Trends

Between 2010 and 2040 the King and Snohomish Counties are forecasted to grow by an additional 520,000 jobs and 160,000 jobs, respectively.

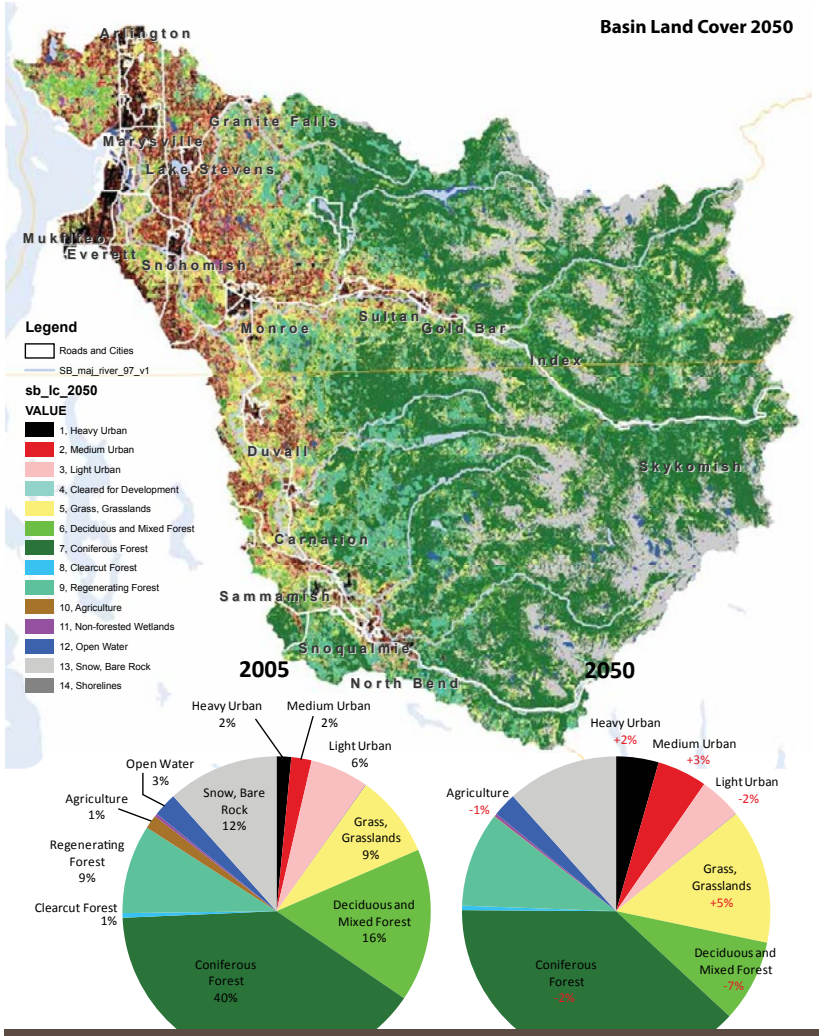
The majority of these jobs will be within the financial, professional, business and educational services sectors (FIRES).

The Basin is forecasted to increase by an additional 150,000 jobs between 2010 and 2040, 57% of these additional jobs are forecasted for the FIRES sector.

Manufacturing is modestly forecasted to grow by 2%. King and Snohomish Counties overall are forecasted to lose over 17,000 jobs.

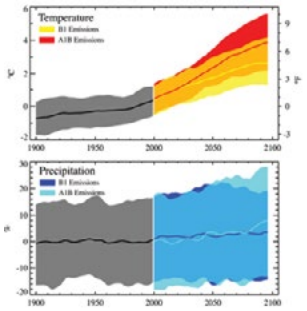
Note: PSRC's forecast was updated in 2006. Since the release of the forecasts, important changes to underlying planning assumptions and trends have occurred, an updated release is slated for Spring 2012.

Economy *forecast data*



Land Cover Change *published data*

Simulation of Annual Changes in Temperature and Precipitation

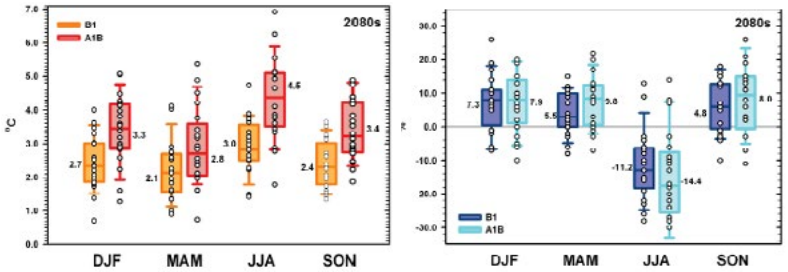


Simulated temperature change and percent precipitation change for the 20th and 21st century global climate model simulations for the Pacific Northwest. The black curve for each panel is the weighted average of all models during the 20th century. The colored curves are the weighted average of all models in that emissions scenario ("low" or B1, and "medium" or A1B) for the 21st century. The colored areas indicate the range (5th to 95th percentile) for each year in the 21st century. All changes are relative to 1970-1999 averages.

	Temperature Change degF	Precipitation Change (%)
2020's	+2.0 (+1.1 to +3.3)	+1.3 (-9 to +12)
2040's	+3.2 (+1.5 to +5.2)	+2.3 (-11 to +12)
2080's	+5.3 (+2.8 to +9.7)	+3.8 (-10 to +20)

(39 combinations averaged for each cell in the table). The ranges for the lowest to highest projected change are in parentheses.

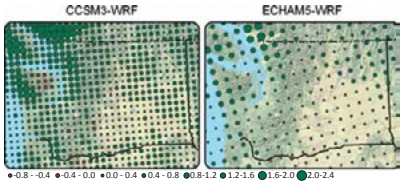
Seasonal Variability



Range (lowest to highest) of projected changes in temperature (red) and precipitation (blue) for each season (DJF=winter, etc.), relative to the 1970-99 mean. In each pair of box- and-whiskers, the left one is for SRES scenario B1 and the right is A1B; circles are individual model values. Box-and-whiskers plots indicate 10th and 90th percentiles (whiskers), 25th and 75th percentiles (box ends), and median (solid middle bar) for each season and scenario. While some precipitation models project increases and some project decreases, the vast majority project decreases for summer and increases for winter by the 2080s.

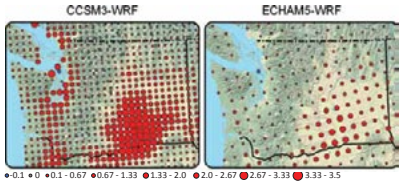
Extreme Events,

Change in the number of heat wave events



A heat wave is an episode of three or more days where the daily heat index (HUMIDEX) exceeds 32°C. The CCSM3-WRF shows considerable increase in heat waves in the lowlands of western Washington.

Change in the fraction of daily precipitation exceeding the 20th century 95th percentile (R95)



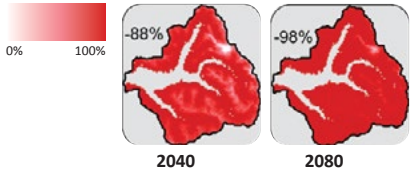
An increase reflects that a greater percentage of precipitation occurs during extreme precipitation events. Both models show increases, with CCSM3-WRF showing considerablly more change.

Climate *forecast data*

Snowpack Loss (SWE)

The hydrology of the Pacific Northwest (PNW) is particularly sensitive to changes in climate because seasonal runoff is dominated by snowmelt from cool season mountain snowpack, and temperature changes impact the balance of precipitation falling as rain and snow.

Projected changes in snow water equivalent (SWE) in the Sultan Watershed for 2040 and 2080 according to the A1B SRES scenario compared with simulated mean historical April 1 SWE (1916-2006) as simulated by DHSVM (below). By 2040, the Sultan is forecasted to lose 88% of April 1 SWE, by 2080 nearly all of the snow (98%) will be gone by the first of April. In the Tolt watershed (not pictured) 79% is forecasted to be lost by 2040, and 95% lost by 2080.



Groundwater

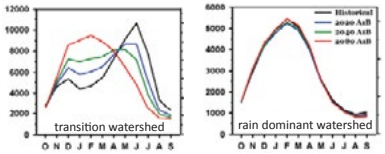
The literature review indicates that a wide range of groundwater impacts could result from climate change. Some studies indicate negative impacts to groundwater recharge related to climate change, while other studies predict increased groundwater recharge. In general, results suggest that changes in precipitation, caused by different emissions of greenhouse gases in the future, influence the amount of recharge. However, in some situations, local conditions, such as evapotranspiration, surface water exchanges, and changes to groundwater pumping, are more significant to groundwater systems than changes in climate. many studies indicate the relative importance of hydraulic conductivity to rivers and changes in river flows to groundwater levels.

Watershed Transitions

Historically, both the Skykomish and the Snoqualmie were transition watersheds. By 2020, under both the A1B and B2 scenarios,the Snoqualmie would become a rain dominant watershed. By 2040 under the A1B scenario, and by 2080 under the B2 scenarios, the entire Basin would become rain dominant.

Streamflow Changes

Transient basins will likely experience significant streamflow shifts, becoming rain dominant as winter precipitation falls more as rain and less as snow. The characteristic double-peak hydrograph of the transition watersheds will shift towards a single-peak characteristic of rain-dominant watersheds (left below). Watersheds that are rain dominated will likely experience higher winter streamflow because of increases in average winter precipitation, but overall will experience relatively little change with respect to streamflow timing. These changes are important because they determine when water is available and how it must be stored.

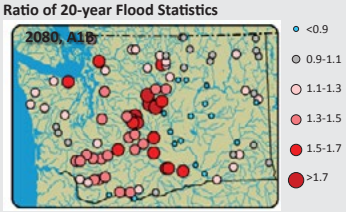


Flow Statistics

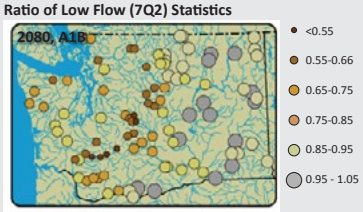
The magnitude and frequency of flooding are predicted to increase most dramatically in the months of December and January for what are now Washington's transient runoff watersheds. Rain-dominant watersheds are predicted to experience small changes in flood frequency.

Reductions in the magnitude of summer low flows are predicted to be widespread for Washington State's rain dominant and transient runoff river basins. Future estimates of the annual average low flow magnitude (7Q2, which is the 7 day average low flow magnitude with a 2 year return interval) are projected to decline by 0-50% by the 2080s under both the A1B and B1 emissions scenarios (see 2080, A1B above). The reduction in streamflow for more extreme (7Q10) low flow periods in rain dominant and transient runoff basins is also predicted to change by a similar amount, ranging from 5-40% (not shown). Further, the duration of the summer low flow period is projected to expand significantly

Ratio of 20-year Flood Statistics



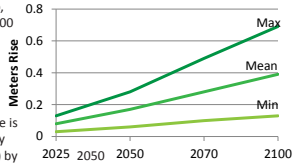
Ratio of Low Flow (7Q2) Statistics



Hydrology *forecast data*

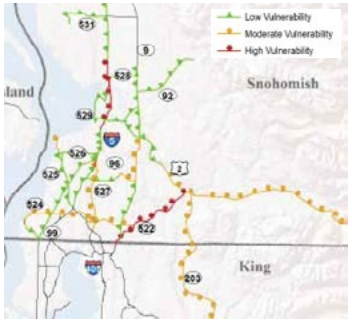
Pacific NW Seal Level Rise

Medium projections of sea level rise for 2100 are 2 inches to 13 inches (depending on location) in Washington State. Substantial variability within the region exists due to coastal winds and vertical land movement. The small possibility of substantial sea level rise from the melting of the Greenland ice cap lead to projections as high as 35 inches to 50 inches for 2100 (depending on location).The IPCC Sea Level Rise projections for moderate A1B scenario, range across the next 100 years and under a minimum, mean or maximum trajectory (see below). In WRIA 7 (Coast from Everett – Marysville) sea level rise is projected to increase by 0.36 meters (14 inches) by under the A1B Maximum.



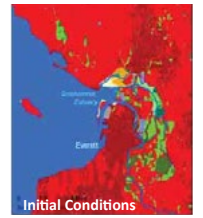
Transportation Vulnerability Assessment

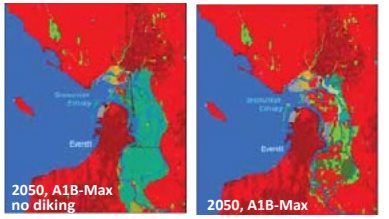
- Northwest Region Area 3 consists predominantly of urban and suburban roads in Snohomish County and US 2 to the region boundary and SR 203 in northern King County. In general, most climate impacts would result in either reduced capacity or temporary road closures due to heavy rain events.
- US 2 has impacts now from flooding and debris moving down the Skykomish River. If sea level rises 2 feet, US 2 could see more log jams collecting on bridge piers, but they would be easier to reach. With 4- and 6-foot sea level rises, the river could overtop the dikes and the water would spread, easing pressure on the bridge.
- US 2 is the sole mountain pass in this Maintenance Area. Climate impacts are anticipated to result in temporary closures rather than closures lasting over 60 days.
- SR 104 at the intersection to the Edmonds ferry terminal already has flooding during high tides and during average tides in heavy rain events. This is expected to increase with higher sea levels. Low-lying roads will be impacted by higher sea levels.
- SR 203 is impacted now by high winds coming off the Cascades. Winds may increase with more extreme weather events.
- In general, with increased heavy rain events, existing drainage ditches and culverts may be undersized for larger events. Roads at the base of steep slopes may see more landslides, but these are not anticipated to close the road for more than 60 days.



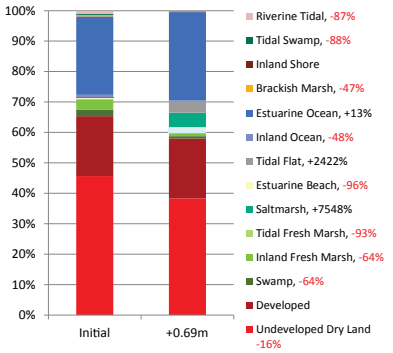
Habitat Vulnerability Assessment

Extensive dikes protect the low-lying dry land and marshes within Everett. This reduces the predicted effects of sea-level rise for this site. Assuming that dikes in this area are able to withstand the predicted increases in sea level rise, the most significant prediction at this site is the inundation of brackish marsh and inland fresh marsh north of Smith Island and west of Marysville. However, it is not unreasonable to suggest that, because many of the dikes in this area were constructed with wood waste from lumber mills and other degradable materials, they may be vulnerable to damages associated with sea-level rise. The Tulalip Tribe and other stakeholders in the region are currently working to remove some of the region's dikes to restore habitat.



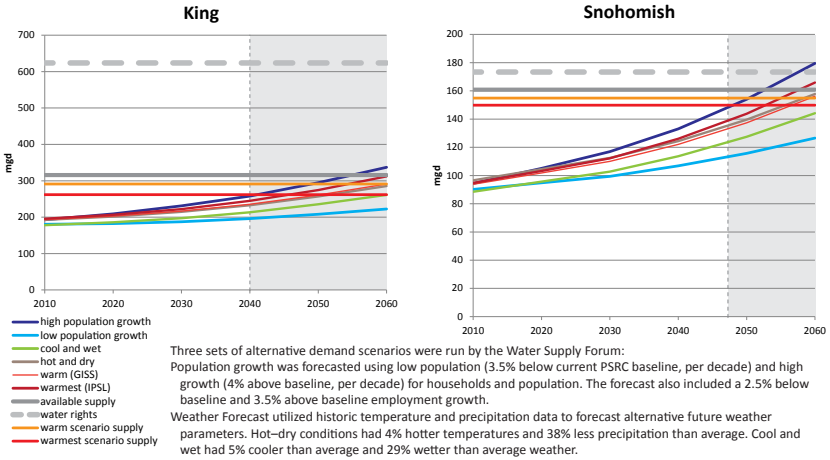


Projections for Habitat Changes for Everett Area, Site 4 Projections for Habitat Changes Assuming no Dikes



Sea Level Rise *forecast data*

Water Supply and Demand



Three sets of alternative demand scenarios were run by the Water Supply Forum:

Population growth was forecasted using low population (3.5% below current PSRC baseline, per decade) and high growth (4% above baseline, per decade) for households and population. The forecast also included a 2.5% below baseline and 3.5% above baseline employment growth.

Weather Forecast utilized historic temperature and precipitation data to forecast alternative future weather parameters. Hot–dry conditions had 4% hotter temperatures and 38% less precipitation than average. Cool and wet had 5% cooler than average and 29% wetter than average weather.

The projected impacts of climate change utilized the A2 and B1 SRES emissions scenario. With A2 representing the warmest (IPSL) scenario and B1 representing the warm (GISS) scenario.

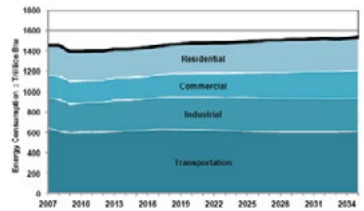
Changes to existing supply was explored. Included in the above diagrams are current water rights

In addition to demand, supply was explored. The total amount of supply is dictated by water rights.

Surface water supply is forecasted to change as a result from the expected seasonal shift in streamflow, with less runoff in late spring and early summer months, which have traditionally marked the reservoir refill period of the region's supply reservoirs. As with demand, the warm scenario represent SRES emissions scenario B1 while the warmest scenario represents A2. The above graphic does not represent new planned or proposed projects which will increase water supply in each County.

Energy Supply and Demand

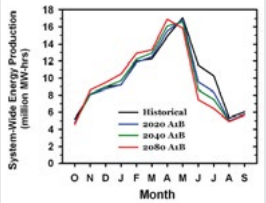
Forecast primary energy consumption in Washington, by end use sector



Washington residential energy expenditures projection through 2035. Expenditures are expected to decline primarily driven by improving efficiency in transportation standards, but also partly due to more purchases of efficient appliances, electronics and heating systems.

Climate impacts on Hydropower Supply

Hydropower accounts for roughly 70% of the electrical energy production in the Pacific Northwest and is strongly affected by climate-related changes in annual streamflow amounts and seasonal streamflow timing.



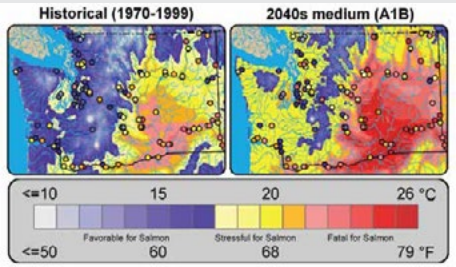
Climate impacts on energy demand due to changes in heating and cooling days

Combining the effects of warming with population growth

	HEDI (heating)	CEDI (cooling)
2020's	22% to 23%	165% to 201%
2040's	35% to 42%	363-555%
2080's	56% to 74%	981-1845%

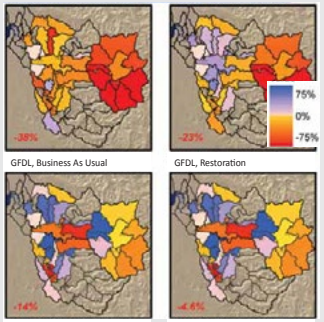
Infrastructure *published data*

Aug. Mean Surface Air + Maximum Stream Temperature



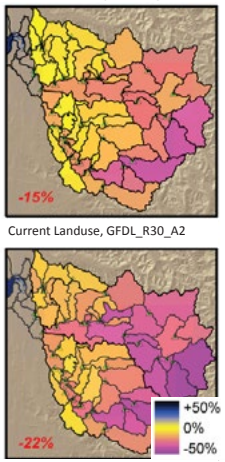
Had-CM3 has slightly more optimistic spawners. The major difference between the two models lies in the seasonal variability of precipitation. GFDL has a big decrease in summer and fall and big increases in Winter, while Hadley is more even across the year. Despite model uncertainty impacts on freshwater salmon are consistently negative. Restoration efforts can offset some of these impacts, more so under the GFDL model.

Change in Mean Returning Chinook Spawners, 2000-2050

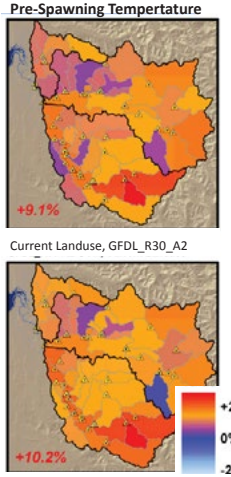


Results of Hydrologic Model on Key Salmon Survival Limiting Factors

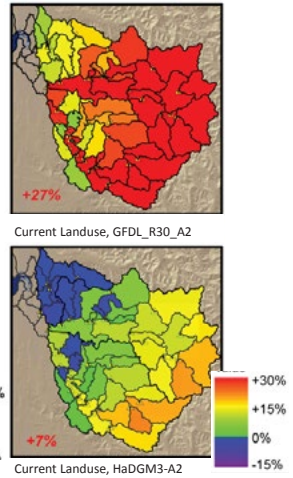
2000-2050 Percent Change in Minimum Spawning Flows.



2000-2050 Percent Change in Average Daily Maximum Pre-Spawning Tempertature



2000-2050 Percent Change in Incubation Flows



Salmon *forecast data*

State of the Basin 2010 Package

This package includes a collection of current statistics and historical trends characterizing influential variables within the Snohomish Basin and surround Puget Sound Region. The graphs, maps and descriptions have been synthesized by the UERL team into seven overarching categories including: demography, economy, development, resource management, infrastructure, hydrology and ecosystems. Included below are the references and links for each set of statistics. This package was developed to support the discussion at the Snohomish Basin Policy Workshop hosted by the UERL on February 24, 2012.

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- **Building Permits:** Washington Center for Real Estate Research. Washington State's Housing Market. http://www.wcrer.wsu.edu/WSHM/WSHM.html
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- **Streamflow graph:** Streamflow rates for Snoqualmie, Tolt, Carnation and Monroe: USGS. http://waterdata.usgs.gov/wa/nwis/nwis
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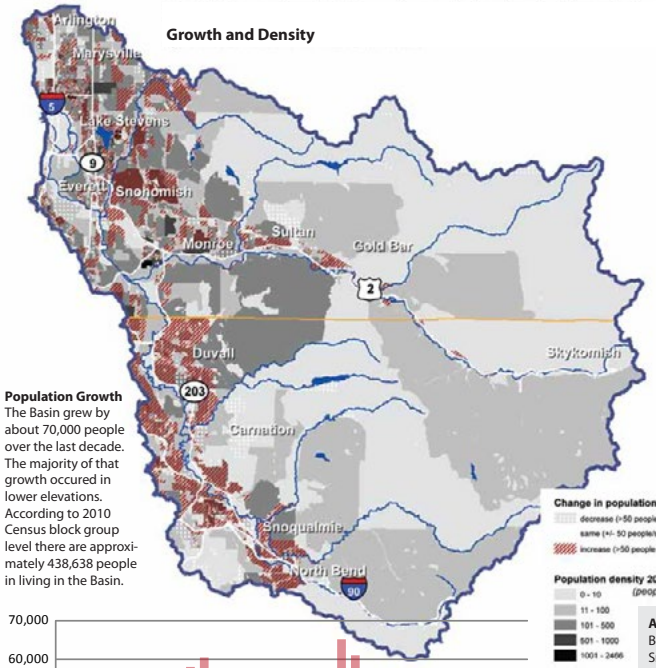
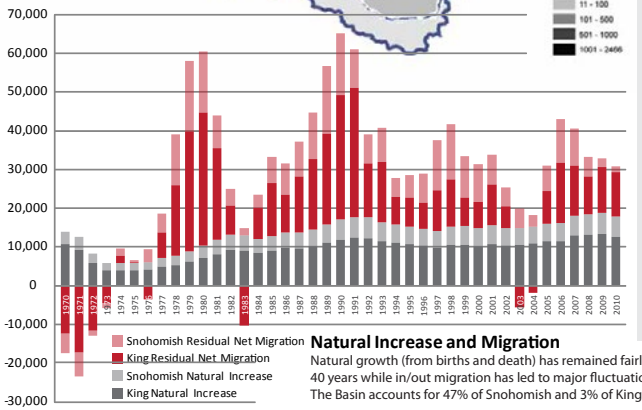
- **Freshwater Stream Alterations:** Synthesis of number of HPAs, per year, and per channel modification, flow control structures and bank protection permits in WRIA 7. WA Dept Fish and Wildlife.

Ecosystems

- **Land Cover 2000:** GIS Analysis conducted by UERL to synthesize WRIA 7 Land Cover classes based on Central Puget Sound Land Cover data published by Alberti, M., Weeks, R., and S. Coe. 2004. Urban Land Cover Change Analysis for the Central Puget Sound: 1991-1999. *Journal of Photogrammetry and Remote Sensing 70:1043-1052.* http://www.urbaneco.washington.edu/
- **Salmon Escapement:** Skykomish/Snoqualmie Basin Chinook Escapement and Return #s from Tulalip Tribes [from Ecosystem Diagnosis and Treatment Model - Shiraz]. Species data from SalmonScape for WRIA7. http://wdfw.wa.gov/mapping/salmonscape/
- **Chinook Location in WRIA 7:** Snohomish River Basin Salmonid Habitat Conditions Review Snohomish Basin Salmonid Recovery Technical Committee. September 2002. Section 4. Status of Salmon in the Snohomish River Basin. P4-2. http://www.co.snohomish.wa.us/documents/Departments/Public_Works/surfacewatermanagement/snohomishsalmonplanfinal/section4.pdf



Population Growth
The Basin grew by about 70,000 people over the last decade. The majority of that growth occured in lower elevations. According to 2010 Census block group level there are approximately 438,638 people in living in the Basin.



Natural Increase and Migration
Natural growth (from births and death) has remained fairly constant over the last 40 years while in/out migration has led to major fluctuations in growth.
The Basin accounts for 47% of Snohomish and 3% of King County's population.

Marriage
Percent of people married dropped from 48% in 1960 to 26% in 2010.

Households
People per household dropped from 3.07 in 1960 to 2.72 in 2010.

Ethnicity
In 1980, only 5.3% of Snohomish County population was considered minority, by 2010 25.7% is minority. The largest increase has been in the Hispanic population, which now comprises 9.4% of the County (4%, 2000). Asian population was also estimated at 9.3% in 2010.

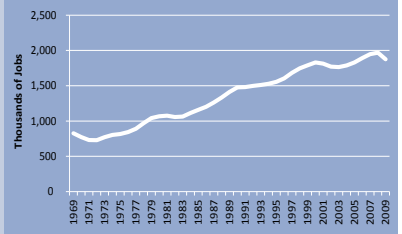
Age Structure
Between 1960 and 2010 Snohomish and King County experienced a growth in older age groups (45+) relative to younger age groups (under 44). However, if we isolate only the age structure in the Snohomish Basin, we don't see a significant trend in aging or loss of younger age groups. Since 1960 there has been an increase in the percentage of the population age 25-44, and a decrease in school age population (5-24).

Demography *published data*

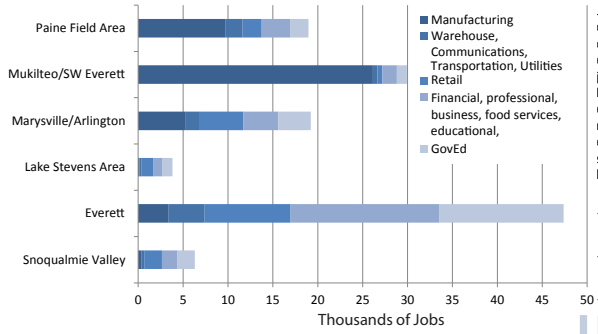
Top Employees of Snohomish County, 2009

COMPANY	TYPE	FTE 2009
Boeing	Aircraft manufacturing	32,000
Naval Station Everett	U.S. Navy Base	6,000
Providence Regional Medical Cen	Medical services	3,200
Premera Blue Cross	Health Insurer	3,200
Tulalip Tribes Enterprises	Real estate, Retail, Gaming	3,020
Snohomish County Government	County Government	2,965
Washington State	State Government	2,800
Everett School District	School District	1,700
Philips Medical Systems	Ultrasound technology	1,600
Verizon Northwest	Communications	1,500
Stevens Healthcare	Health care	1,400
Zumiez	Sporting Goods	1,400
Aviation Technical Services	Aircraft repair/maintenance/parts	1,400
Everett Clinic	Health care	1,400
Edmonds School District	School District	1,350

Number of Jobs in the Puget Sound Region

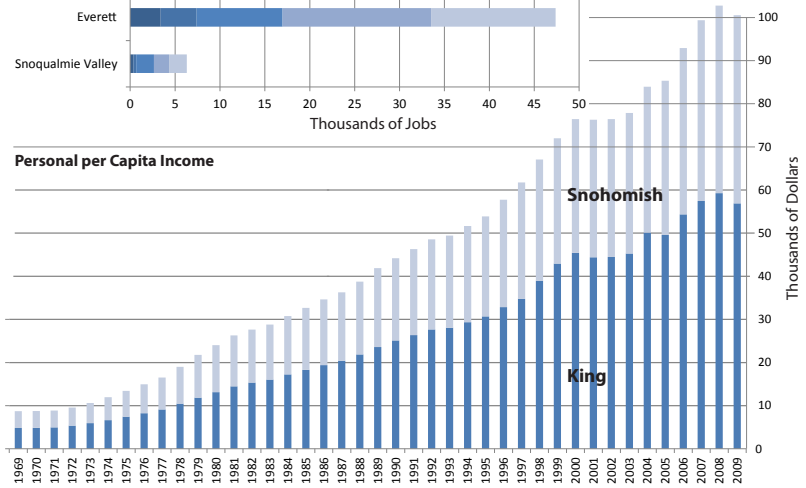


Jobs per Sectors *2006*



Jobs in service industries now dominate an increasingly diverse central Puget Sound economy. In the early 1970s, military and manufacturing jobs each outnumbered services jobs. In 1980, services were growing, but the economy still relied primarily on manufacturing and government employment. By 1998, services surpassed all other sectors as the largest sector of the regional economy.

Personal per Capita Income



Economy *published data*

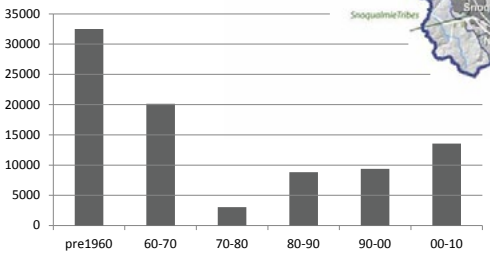
Urbanization Stats

According to the US Census, in 1960 40% of the Basin Population resided in Urbanized areas while in 2000 that figure rose to 85%.

According to the PSRC, in 2007, 94.9% of new housing was inside King County's Urban Growth Areas, and 83.5% inside Snohomish's UGA.

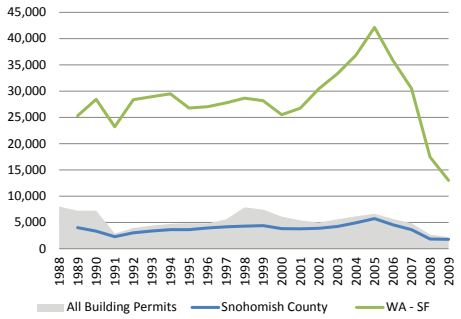
Between 2000 and 2007 24% of new housing units were within Metropolitan Cities in the Central Puget Sound. 2&% occurred in inner suburban areas while 48.5% occurred in outer suburban areas. PSRC 2008.

Acres of Annexed Land

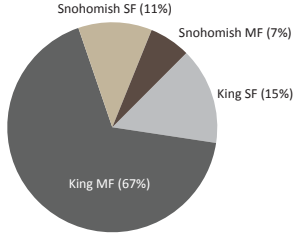


About 32,000acres of land had been annexed into cities by 1960s. The majority of cities had been incorporated around the turn of the century. Over the last 50 years another 55,000 acres had been added. Currently about 5.5% of the Basin is incorporated.

Building Permits



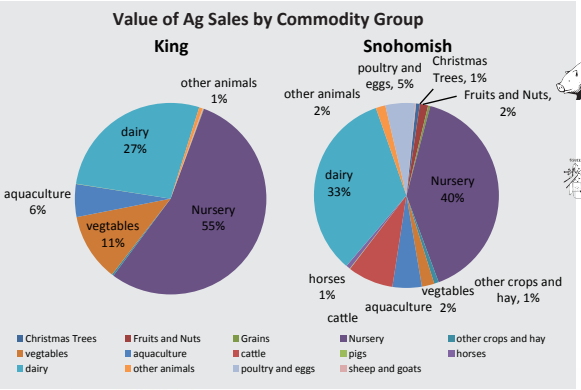
SF vs. MF Housing Households

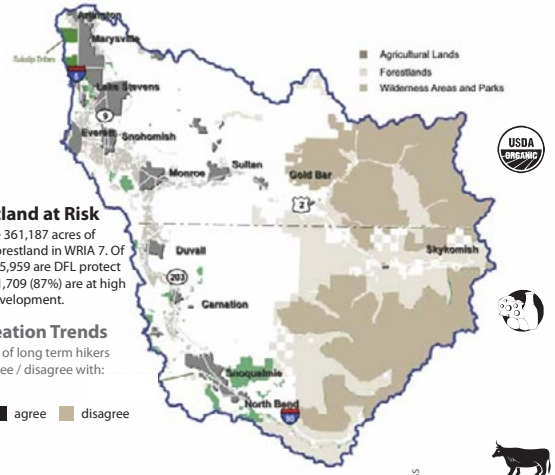


Rent as percentage of income

According to the US Census Bureau, in 2007 36% (the majority) of households spent more than 35% of their monthly income on gross rent. In 1989, the majority (>30%) of households spent less than 20% of their monthly income on rent.

Development *published data*



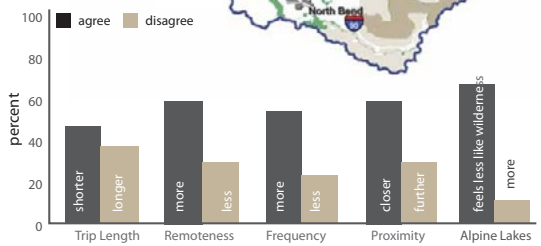


Forestland at Risk

There are 361,187 acres of private forestland in WRIA 7. Of those, 185,959 are DFL protect while 151,709 (87%) are at high risk of development.

Recreation Trends

percent of long term hikers that agree / disagree with:



Agricultural Statistics

Revenue
Snohomish County farmers sold more than $154 million in agricultural products in 2002. 89% of farms in King, and 87% of farms in Snohomish County bring in less than $50,000 in annual revenue.

Direct Marketing
Many of the strategies for increasing the viability of agriculture in Snohomish County are based on increasing markets and developing value-added or niche products. In western Washington, Snohomish County has the greatest number of farms that sell direct to individuals. In 2002, 284 or 18% of all farms reported selling direct to individuals either through roadside stands, farmers' markets, pick-your-own sites, or other means, an 8% increase since 1997. In King County 237 farms sold directly representing a 15% increase since 1997. The number of farms selling directly is believed to have increased especially in more recent years.

Certified Organic
2002 was the first year for which data on the number of farms that are certified organic was tabulated by the US Agriculture Census. In 2002, 25 farms, or 2% of Snohomish County farms, reported being certified organic. 41 farms, or 3% of King County farms were certified organic.

Dairy
In 2002 there were 84 dairy farms, down from 108 in 1997. In addition, the number of farms selling dairy products also declined over the same period. However, dairy still represents a significant portion of the agricultural sales in Snohomish County at more than $42 million dollars in 2002.

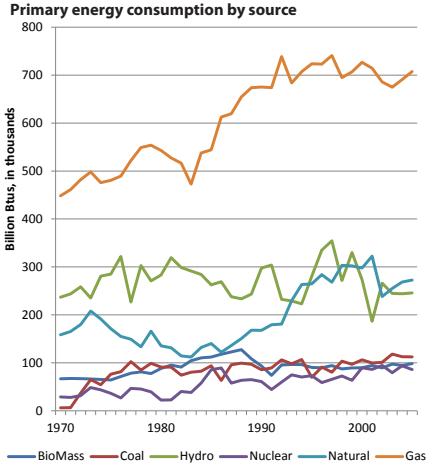
Cattle
Cattle and calves represent the third greatest sales producing commodity in Snohomish County at more than $10 million in 2002.

Horses
In 2002 there were a total of 4,907 horses and ponies in Snohomish County, which ranked fifth among Washington State Counties.

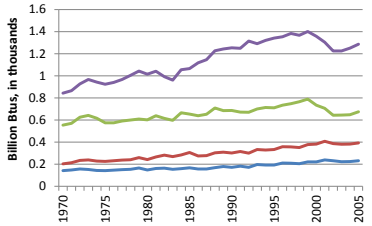
Resource Management *published data*

Energy in the Basin

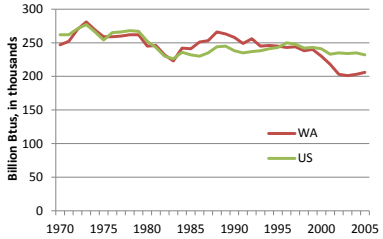
Primary energy consumption by source



Energy consumption per end sector



Energy consumption per capita



Water Supply in the Basin

The major sources of the Basin's water supply are surface diversions on the Sultan and Tolt that collect natural runoff originating from the Cascade Mountains. Groundwater is also a significant source for some of the water providers in the region. In 2005, it is estimated that surface water comprised 66% of the region's total supply; while groundwater comprised 34%.

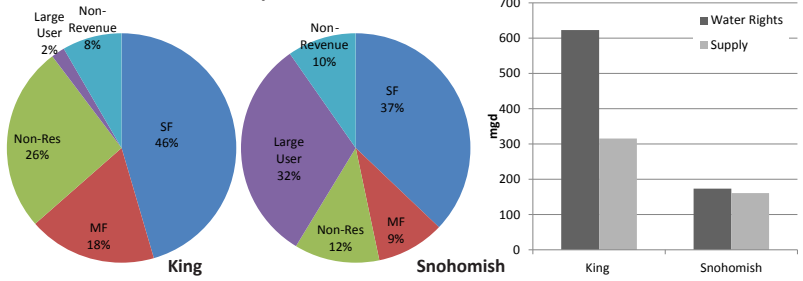
The municipal groundwater sources are tapped by wells with depths ranging from less than 100 feet to more than 1,000 feet.

Municipal water demand does not include agricultural water use or water used by industries that have their own water supply, such as private wells.

The total current demand for water in 2010 for Snohomish County 92 mgd and In King County, 168. The current supply within Snohomish and King counties is 160.9 and 315.6, respectively.

Single Family households utilize ~130-370gallons/day. Multiple Family households use less, at ~40-255 gallons/day. Non-residential customers are calculated by gallons per employee per day, at an average 57gped for the Region. Large Water users utilize ~30mgd.

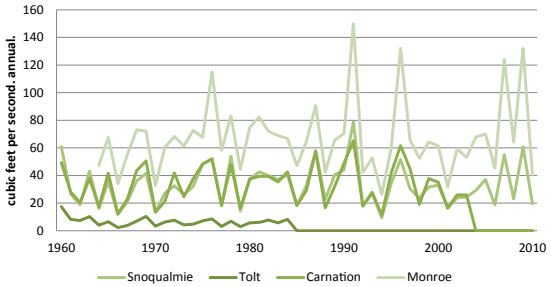
Percent of Total Water Demand by Sector



Infrastructure *published data*

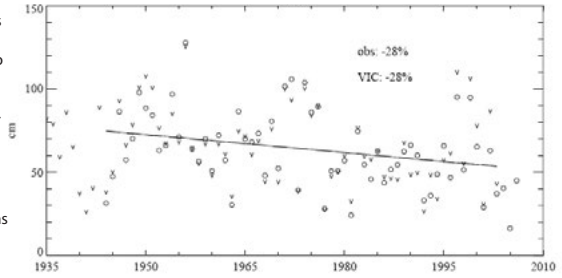
Streamflow

Annual streamflow in the watershed varies widely from one year to the next in a pattern which reflects annual precipitation. Long-term trends in annual streamflow will be affected by trends in precipitation, water consumption and land use practices. Recent analysis of annual streamflow trends, adjusted for precipitation, is inconclusive but suggests a possible reduction in streamflow over time.

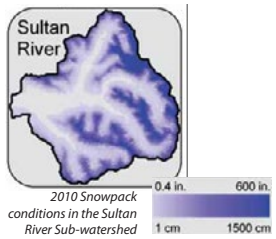


Snowpack

Nearly every glacier in the Cascades and Olympics has retreated during the past 50-150 years in response to warming. Small glaciers are disappearing rapidly, and glacial mass is being reduced on the larger ones. While the total water input into Puget Sound from melting glaciers is minimal, glacial retreat can have important local effects. In higher reaches of certain river basins (such as the Nooksack) and some tributaries to the Skagit, melting glaciers provide a substantial portion of stream flow in late summer. Glaciers also have significant local effects on stream temperature and water supply for aquatic plants and animals. Significant reductions in glacial input to streams would dramatically alter vulnerable aquatic habitat.

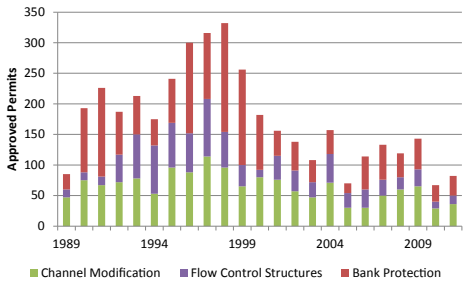


Regionally averaged 1 April SWE for observations (o) computed for the 1944–2006 snow courses using area-weighting and infilling of missing values with best-correlated time series, and VIC (v). The VIC values have been scaled to the mean observed SWE. Linear fits for observed (solid) and VIC (dashed) overlap.



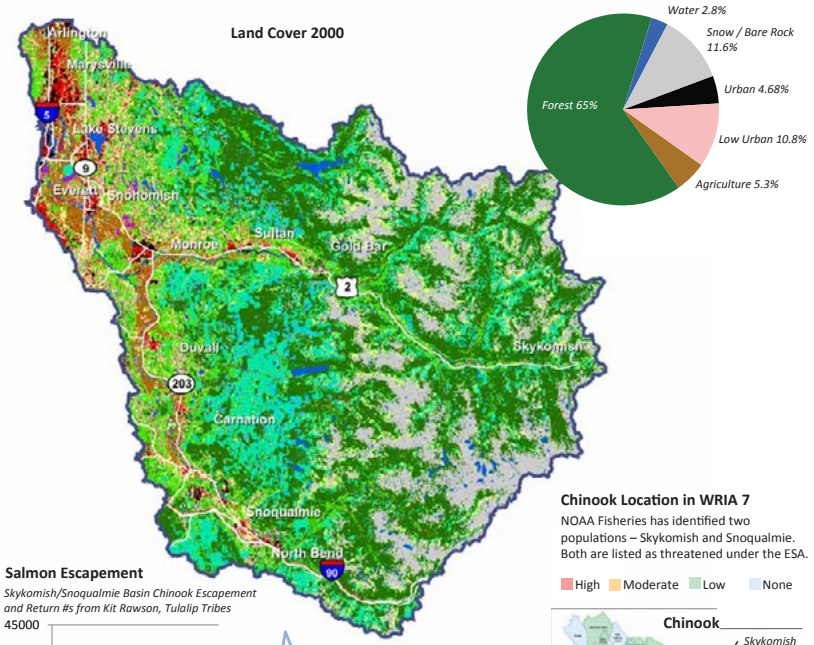
2010 Snowpack conditions in the Sultan River Sub-watershed

Freshwater Stream Alterations



Number of HPAs, per year, and per channel modification, flow control structures and bank protection permits in WRIA 7. WA Dept Fish and Wildlife

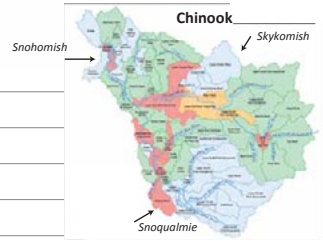
Hydrology *published data*



Chinook Location in WRIA 7

NOAA Fisheries has identified two populations – Skykomish and Snoqualmie. Both are listed as threatened under the ESA.

High Moderate Low None



Salmon Escapement

Skykomish/Snoqualmie Basin Chinook Escapement and Return #s from Kit Rawson, Tulalip Tribes

Ecosystems *published data*

Exercise 1: Decisions under Uncertainty

You are a member of an ad hoc task force appointed by Snohomish County in partnership with all local governments involved in the Snohomish Basin to develop a strategic plan aimed at protecting the long term watershed function in the Snohomish Basin. You represent your agency or other organization at the table. The EPA has committed to fund three projects within the next twelve months to help meet your goals. Please find attached a selection of eight projects identified as alternative approaches to maintain watershed function in the Basin over the next fifty years. The task force must agree on which three of the eight strategies to fund. A designated Science Team has identified 4 indicators of water quality and quantity to monitor in order to evaluate the performance of the selected projects; stream temperature, nutrient concentrations, and base flows and flood frequency. Please find attached a brief description of the four indicators. The Science Team has also supported today's decision making process with a quantitative model to forecast changes in indicator values associated with selection of alternative strategies.

Small Reservoirs: Reservoirs detain upstream flows, and can be used for multiple purposes including provision of water (drinking, irrigation), hydro-electric energy, and flood protection. Reservoirs can be managed to release cool water during low flow times (e.g. summer, drought). Reservoirs require a very costly initial investment for their construction and planning (e.g. Environmental Impact Statement). While small reservoirs don't carry the significant environmental impacts of major dams and reservoirs (i.e. hydrological and biotic disconnection), they still interrupt fish migration and sediment flows. Small reservoirs will likely be most effective if the region experiences major snowpack decline, which would exacerbate winter flooding and summer drought extremes.

Purchase of Development Rights (PDR) in Upland Forests: PDR refers to a planning program whereby the landowner voluntarily sells the 'right' to develop their land in the future to a government agency, thereby restricting the type and amount of development that may take place on their property. This strategy focuses on upland forests which have deep soil horizons capable of infiltrating runoff and recharging groundwater aquifers. Reduced overland flows and increased groundwater flows are expected to increase base stream flows, reduce summer stream temperatures, and reduce frequency of low-intensity flood events. By reducing the rate of runoff, input of nitrogen and phosphorus pollution may be reduced. This program does not restrict harvesting of timber and other resource management activities. This strategy is most effective if the margin between timber value and real estate value is close. In other words, if real estate value is much greater than timberland value, the incentive to sell rights is not present for the landowner, and if timberland value is much greater than real estate value, than the threat of conversion is suppressed.

Floodplain Conservation Easement: Conservation Easements restore and protect the functions of the floodplain. Landowners voluntarily sell the easement to their land within a floodplain to a government agency that then actively restores natural features and characteristics of the floodplain by re-creating the topographic diversity, increasing the duration of inundation and saturation, and providing for re-establishment of native vegetation. This program restricts farming and other resource management activities. Landowners retain the right to control public access and passive recreation. The restored floodplain acts like a sponge, soaking up water during peak flows to reduce flooding. Streamside (riparian) vegetation can reduce stream water temperature through shading, and reduce nitrogen and phosphorus concentration through plant uptake of these nutrients. While an effective tool to support salmon restoration, lowland farm communities generally oppose this program. An unintended consequence of restored floodplains is the increased flooding on adjacent parcels; as stream flows are effectively slowed, a bottleneck is created and upland parcels may experience more frequent periodic floods. This program works best if large contiguous parcels are restored and if flooding is frequent and intense enough to warrant the removal (or relocation) of farmlands.

New Building Impervious Surface: New regulation requiring all new developments (industrial, commercial and residential) to include a minimum 1:2 ratio of natural vegetation to impervious surfaces. In other words, for every square foot of roof, driveway and hard surface the developer must include at least half a square foot of tree cover, natural grasses or native drought-tolerant plants. If a minimum area cannot be met, developer can employ alternative Low Impact Development strategies (e.g. greenroofs or cisterns). The primary objective is to decrease urban runoff. This strategy is most

effective at reducing nitrogen and phosphorus concentrations and minimizing extreme stream temperatures during frequent high-flow events (e.g. 48 hour storm). This strategy is most appropriate during periods of fast urban growth, especially of greenfield developments.

Water Tax: An increase in the cost of water during summer months when supply is low is imposed on households and industry (e.g. cooling and irrigation uses). The objective is to reduce withdrawals through market disincentives that indirectly increase efficiency, thereby bolstering in-stream flows during a characteristically low base-flow period. A water tax is not expected to benefit flood mitigation. By increasing the volume of water in streams, the effect of rising temperature and nutrient concentrations may be minimized. This strategy is most effective when consumption is in-efficient or wasteful. The unintended consequence of this strategy is an increased (regressive) burden on low-income households and struggling businesses such as small farms. In addition, if consumers are already operating at very efficient (minimal) rates, this strategy would not reduce consumption by much.

Phytoremediation Wetlands: Phytoremediation (from Greek: phyto=plant and Latin: remedium=remediation) describes the use of plants to mitigate environmental problems without the need to actively remove pollutants and dispose of them elsewhere. Phytoremediation wetlands are engineered to filter out inorganic fertilizers, minerals and toxins that contaminate waterways. These wetlands detain overland flows to increase water residence time needed for plants to remove the contamination. This process can indirectly benefit flood mitigation and reduce stream temperatures. Wetlands are generally engineered to be separate from groundwater flows in order to reduce threat of contamination, and therefore do not aid base flows. Phytoremediation wetlands are most effective if constructed downhill from clustered pollution source (e.g. urban development). In other words, this strategy works best when development is compact, not dispersed.

Agricultural Incentive District: An agricultural incentive district is a designated boundary within which participating farmers comply with a set of restrictions in exchange for a monetary benefit (e.g. reduced property tax). This proposed strategy specifically addresses the use of pesticides and fertilizers within floodways. This strategy can be highly effective at reducing stream nutrient concentrations from agricultural runoff. Temperature, base flow and flooding would not be affected by this planning tool. For this strategy to work well, there would need to be a lot of farmland in the Basin, and a desire for farmers to comply (i.e. the benefit of reduced taxes is greater than the lost revenue from not using fertilizers).

High Efficiency Household Water: A program to increase the efficiency of household fixtures and appliances to reduce water consumption. Municipalities (cities and counties) would provide in-home installation of low-flow fixtures (e.g. aerated showerheads) and provide discounts towards the purchase of new high efficiency (HE) appliances such as dishwashers, washing machines and low-flow toilets. This program would especially support low-income households who might not be aware of, or able to afford these conservation measures. If effective, the program could in-directly improve summer base-flows by reducing withdrawals. This program is not targeted at flood mitigation or water quality measures, however by increasing the volume of water in streams, the effect of rising temperature and nutrient concentrations may be minimized. This program would be most needed if snowpack decline reduces summer water availability.

WATER QUALITY AND WATER QUANTITY MEASURES

The Snohomish Basin supports a multitude of resources and processes that are supplied by natural ecosystems. Collectively, these benefits are known as **ecosystem services** and include products like clean drinking water and processes such as the decomposition of wastes. Each strategy is associated with potential progress towards maintaining and improving future ecosystem service provisioning with regards to water quality and quantity. In an effort to evaluate tradeoffs across the strategies, the Snohomish Basin Resource Team selected two measures of water quality and two measures of water quantity: stream temperature and nutrient (nitrogen and phosphorus) concentrations for water quality, and flooding (magnitude and frequency) as well as low flows for quantity. The selected measures were chosen because they were determined to be the most 1) relevant to identified critical challenges in the Basin today 2) easily understood by a large audience 3) readily available 4) accurate and 5) sensitive to differences between the strategies. Below, we describe each of the four measures in terms of their current importance and potential challenges.

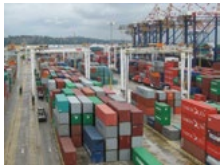
Stream Temperature: Stream temperature governs the kind of aquatic life that can live in a stream. Fish, insects, zooplankton, etc. have a preferred temperature range. Temperature also influences water chemistry. The rate of chemical reactions generally increases at higher temperatures, which in turn affects biological activity. Already many Basin streams are classified as 'impaired' due to poor temperature conditions. Major challenges to temperature in the Basin include runoff over impervious surfaces (e.g. asphalt), in terms of the timing and volume, infiltration rates in upland areas (associated with alternative land covers from urban to forest), climate change (as affected both by warming atmospheric temperatures and shifts in precipitation and snowmelt), and reductions in shoreline vegetation (which provide shade).

Phosphorus and Nitrogen Concentrations: Nitrogen and phosphorus in fertilizers, livestock and pet wastes dissolve in rain or irrigation water and wash into the soil. Sewage and septic systems sometimes leak, also contributing to high soil nutrient levels. While some is used up by plants, the rest migrates into water bodies where is can cause algal blooms, reducing dissolved oxygen concentrations. This is especially critical for NW streams because cold water fish, such as salmon, require high oxygen levels. Algal blooms also lead to beach and shellfish bed closures as they may be toxic, posing a public health concern. Rivers from fast-flowing urban and agricultural areas typically have the highest inputs of nutrients. Phosphorus is currently a major problem in many Basin lakes.

Flood Magnitude and Frequency: Seasonal variation in stream flow is natural and expected. When the magnitude and frequency of variability exceeds historical trends, it poses a significant challenge to built lands in lower elevations (i.e. floodplains). Urban development is affected as infrastructure (roads and utilities) and properties incur costly damages and disruption of services. Flooding in agricultural lands leads to damaged crops, livestock and built structures. Aquatic wildlife and vegetation can also be affected by floods. Floods associated with urban runoff carry warmer temperatures and higher levels of pollutants. Floods can also increase sediment loads and disrupt streamside habitat. King and Snohomish County have the highest cost impacts from floods in the States. The Basin has experienced significant increased flooding as land cover and drainage rates changed from development. In the future, snowmelt timing and precipitation variability is predicted to exacerbate these effects with an increase in both flood frequency and magnitude.

Low Flows: Just as too much water poses a challenge, not enough water can be dangerous and costly. The Snohomish Basin has abundant water resources: enough to support over 1 million residents' drinking water, as well as industry cooling, agricultural irrigation, hydropower, with plenty left over for aquatic life. The challenge lies in the timing of flows, and the low precipitation volumes in the summer. Many of the Basin's streamflows are controlled by upstream dams. As the Basin's population and economy grows, higher withdrawal demands are stressing summer low base-flow supplies. Climate forecasts further warn that the spring snowmelt we rely on to dampen low summer precipitation rates may occur earlier in the year and be gone by summer. Low summer flows drive higher water costs (domestic and industrial) and great stress on salmon and other aquatic species.

Acceleration



The Basin's economy rebounded quickly and strongly after nearly a decade of recession early in the century. Biotech and health services located along the I-5 corridor, ushering in thousands of new jobs. The Providence Regional Medical Center expanded its campus to support the growing sector of retiring generation Xers in the Basin. The Port of Everett also experienced significant growth, improving West Coast and Pan-Pacific connections, surpassing both the Port of Seattle and the Port of Tacoma in cargo. Just outside the City of North Bend, a new outdoor outfitter opened their new headquarters and purchased five-hundred acres as a private outdoor playground, supporting per fee hunting, mountain biking and ATV trails.

The Basin was the fastest urbanizing area in the State of Washington. Housing and commercial development was catalyzed both within and outside of urban centers. Cities like North Bend, Marysville and Lake Stevens increased their growth boundaries to accommodate the surplus of growth. Smaller cities, like Gold Bar, Sultan and Skykomish, struggled to expand their government services in pace with additional growth. Citizen prioritized more reliable utilities, services for a growing aging population, better schools and improved traffic conditions.

Many successful regional capital projects were implemented as a result of increased wealth and investment opportunities. Tolls along I-5 and I-90 funded PSRC's Full Transportation 2040 Plan.

Increased water demands spurred additional groundwater withdrawals, serving an additional 80mgd from the Getchell Plateau aquifer source. Flood mitigation measures included new and restructured levees protecting over 100 acres of lowland communities. This networked system of flood prevention boasted the development of 50 acres of recreation corridor with active sportfields, bike trails and wildlife viewing habitat.

The role of local government changed dramatically. As many Basin cities grew, so did their power to annex surrounding lands. Despite many challenges, by 2060 County government is essentially eliminated west of Snoqualmie and Sultan. Large industry leaders increased their influence in the political arena. Permitting processes were significantly streamlined and cumbersome environmental oversight was minimized. As the pace of urbanization exceeded institutional capacity, many public services became privatized. Contractors were hired by municipalities to perform traditionally government jobs. Nationally, political decisions led to down-sizing government control; restructuring and eliminating many federal agencies including the EPA, FEMA and BLM.

Working lands were squeezed by increasing costs and degrading environmental conditions. Winter floods became more frequent due to upland development. These floods carried heavily polluted water and sediments onto farm fields, destroying hundreds of acres of crops and eliminating the opportunity to raise cattle year-round in the Basin. Despite subsidies, mitigation projects and regulations, the ability of the floodplains to sustainably produce food in the Basin was lost. However, several farmers transitioned successfully to greenhouses, vertical production, and higher

elevation fields, supporting a higher intensity food production. Upland industrial forests were met with conflicts from nearby residents, increased opportunity costs for development and competition from Latin American timber industries. By the 2060, most of the timber production occurred on small-parcels by homeowners pursing a disposable income hobby.

As for climate variability, perhaps the natural variability of the Basin was enough to mask significant changes, perhaps the models over-estimated the degree of impact, or perhaps the Basin was more resilient than initially anticipated. Regardless of the reason, while temperatures rose modestly, and while streamflows transitioned to earlier snowmelts, the majority of the Basin's environmental changes stemmed more heavily from urbanization than any systematic shift driven by global climate change. Globally, natural disasters did occur with increasing frequency and magnitude. Third-world nations were hardest hit, leading to immigration pressures and the need for global aid. Basin leaders reached out with their support, often leading to extended economic growth for labor, resources and research in the Region.

The ecological integrity of the Basin was strongly impacted by the rapid urbanization in the Basin. However, many important characteristics of the system were conserved for the health and enjoyment of the Basin population. Earlier snowmelt flowing over expanded roadways and housing developments heightened winter scour and reduced summer flows, raising stream temperatures and pollution concentrations along lowland riparian habitats. Several pest and bacterial outbreaks led to the public closure of several streams and small lakes. Residential communities along rivers and lakes supported recovery efforts to treat and reclaim

waters utilizing innovative biotechnologies. While five out of the 12 wild salmon stocks declined beyond hope of recovery, new sustainable hatcheries supported the continuation of salmon survival in the Basin including the Pink, Steelhead and Cutthroat Trout.

Small

The economy of the Puget Sound never quite rebounded as initially anticipated. Global competition led to out-sourcing and relocation of many high skilled and manufacturing jobs. By 2060, Boeing's Paine Field operations closed their doors. The Basin was home to many start-up companies, many of which were very successful, but the overall unemployment rate stayed at around 10%. While a growing sector of the Basin's population was retired, those entering the workforce, generation Y, were hardest hit by the long term recession.

On the flip-side of economic challenges, urbanization pressures declined. Population growth rates stabilized at around 10% per decade. The rate of new building permits declined, as did the overall rate of land conversion. The average household size stabilized after over fifty years of continuous growth, as a larger percentage of young adults moved in with extended family and friends. The percentage of multiple-family housing developments rose with declining wealth and rising costs of living relative to household income. As land values declined, the conversion of farmlands and working forests into new subdivisions lessened dramatically.

The long-term economic recession crippled large stakeholders, bringing to the table new actors. As big industry lost their purchasing power, a young, highly educated, but out of work, population drove a new form of activism reflecting their demographic characteristics: highly diversified, egalitarian, technologically savvy and cooperative. Numerous grassroots organizations sprung to support new informal communities, from neighborhoods to shared interests. While highly varied in approaches and causes, these organizations shared a focus on investing in the environment as if their life depended on it. The notion of nature as being fragile, and the need to avert risks refocused priorities. Values around equity, responsibility, public and environmental health, family values and leisure prevailed over the recent era's mantra of competition and personal advancement.

The Basin's population adapted institutional frameworks and investments to make do with highly reduced budgets. New policies pushed improvements in natural capital, greater levels of oversight and accountability, and repairs. Utilities and infrastructure agencies were forced retrofit existing structures and abandon failing projects. For example, washed-out forest roads were removed and several aging levees were eliminated. The conservation of existing resources was prioritized, increasing efficiencies and reducing consumption to make do with less. A diverse set of new small-scale technologies came on-line, characterized by low initial investment and flexible structures, including low-impact development techniques such as greenroofs and bioswales, run-of-the-river shallow dams, and alternative low-fuel transportation modes. Incentive programs were developed to support local industry, including subsidized flood insurance for farmers, paying for damaged crops and livestock and improved farmland preservation. Despite good intentions, most innovative practices failed due to lack of funding, poor coordination and competing interests.

Shifted dominant social values and the rising cost of urban living fueled migrations back into the Basin's resource lands. New farms were characterized by small parcels, a humble deep ecology ethic, but a lack of traditional agricultural knowledge. Innovative farming practices, from direct marketing to organic produce dominated farming practices in the valley. New communities leveraged technologies to share resources, knowledge and labor. The role of the Tulalip Tribes expanded far beyond the reservation, purchasing upland forests and collaborating on several restoration and water storage projects. While funding for park maintenance and acquisition was lost, organizations such as the Washington Trails Association, Mountain to Sound Greenway and the Mountaineers invested thousands of volunteer hours towards trail maintenance and noxious weed removal.

Climate impacts, while minor, were highly apparent to a population that is intimately close to the landscape. Earlier snowmelt transitioned in several watersheds to higher winter flows and lower summer flows. Higher annual temperatures increased the growing season, benefiting agricultural and forestry practices. In-stream flows were heavily regulated, ensuring adequate supplies for salmon. While the number of farms and rising temperatures led to increase demand for irrigation, efficient technologies reduced groundwater withdrawals, while adaptive rotation cycles increase infiltration and recharge. Drinking water supply challenges were minimized due to low growth rates and reduced consumption levels.

Culminating from minor climate impacts and limited land conversion, monitoring of past restoration projects revealed benefits. Enthusiasm over past successes catalyzed numerous different volunteer groups to conduct site-level stream habitat improvements across the Basin, improving fish passage and restoring riparian vegetation. Unfortunately, small-scale projects largely failed to scale-up into a bigger picture. The efficacy of individual actions became increasingly dependent on adjacent uses, leading to greater complexity of dispute resolutions. As resource and recreational use in the Basin rose, so did conflicts between different interest groups.

By 2060, the Basin saw modest improvements in biodiversity and overall ecosystem health. The greatest challenges were coordination and funding. A sea of highly accessible information overwhelmed the rapidly growing number of small-scale institutions. Without strong leadership, the energized bottom-up approach lacked coordination and a big-picture perspective. With increasingly stressed agency budgets and great effort spent on 'the process,' contentions rose between highly active yet divergent interest groups. While many small battles were won, efforts that required larger regional investments dragged on for decades.

Resistance

In January 2018, the City of North Bend declared a Presidential Flood Disaster after an unprecedented 500 year flood covered 90% of the City and over 800 homes were inundated. Major investments poured in to rebuild flood walls and redevelop homes, businesses and damaged infrastructure. In the following decade five additional presidential floods occurred within the Basin, each resulting in significant investments towards strengthened flood protection measures and redevelopment of community resources. Public funds were diverted towards emergency response programs and several social programs, from education to environmental services, suffered significantly diminished budgets.

Climate changes were pervasive throughout the Snohomish Basin and Region. By 2060, over 80% of snowpack was eliminated from both the Tolt and Sultan watersheds. The South and North Fork of the Skykomish suffered near-drought summer conditions, and exacerbated winter flows that scoured edge habitat. Low lying urbanized streams, including the Pilchuck, Raging and Tolt, incurred near-toxic summer flows from high temperatures and polluted waters when the legacy effects of urbanization combined with hydrological shifts. Along the coast, sea level rise lead to over 1,500 acres of additional salt marshes and 200 acres of tidal flats, at the expense of estuary beaches and freshwater and brackish marshes.

The economy in the Basin ebbed and flowed with the each tide of new disasters and reconstruction. Thousands of new jobs supported levee construction, new housing developments, road and wastewater facility repairs, as well as government emergency services. The majority of new jobs included seasonal or temporary positions and many workers lived in poor conditions or continued to live outside the Basin. Securing economic growth and employment stability was prioritized over long-term environmental concerns. Government programs attempted to incentivize business retention and relocation into the Basin by reducing regulatory overhead and costly permitting processes. Boeing stayed within the Basin but followed a boom and bust cycle of job loss and growth. By the 2060, the Port of Everett shut its doors, after over 135 years of business. The cost of repairs associated with sea level rise and the competition with the new Pan-Maxes proved too challenging a hurdle to overcome.

The costs and challenges of water and energy provision grew at a regional level as demands were coupled with increased natural variability and inflexible infrastructure. The Tolt and Spada Reservoirs were depleted by the summer of 2045 and 2048, respectively, as low summer flows and increased demand associated with higher summer temperatures led to supply shortages. Energy provision by PSE was frequently interrupted by downed power lines from severe storms in the winter and hydroelectric shortages from low flows in the summer. Political turmoil over intermittent services and consequent health impacts led to fast-tracking several projects with minimal environmental oversight. Groundwater withdrawals were expanded, steel powerlines replaced wooden poles, and several small dams were permitted along higher elevation streams within the Central Puget Sound. The cost of implementation of these new infrastructure projects were offset by increasing utility costs to customers. New residential homes on exempt wells and with alternative energy sources did not incur these costs, inadvertently leading to higher development pressure outside of service areas and spurring innovation of off-grid technologies.

The population of the Basin can best be described by the growing social disparities between the 'haves' and the 'have-nots'. Despite floods and costly repairs in lower elevations, many of the wealthier households were largely unaffected by the aforementioned changes. Suburban houses, largely in higher elevations, relied more heavily on private services to supplement failing utility and governmental services. Higher income households invested in 4-wheel vehicles able to forge through high water, sent their kids to private schools and private doctors, purchased back-up generators and filtration devices, and enjoyed private access to natural areas. The same cannot be said for lower income groups, especially aging households and a growing community of migrant families. Aging households along low-lying areas were most vulnerable. Damaged houses incurred thousands of dollars of damages. Flood insurance pay-offs were eventually eliminated as Federal funding ran out and regional funding was equally diluted. For those households that received compensation, the cost of redevelopment was often greater than their house value. Aging homes and lower mobility populations were heavily hit by inconsistent service provision, especially during heat waves and cold spells. Many of these populations were also uninsured as regional services were severely cut. As global and regional costs associated with gas, food and services increased, the percentage of income spent on necessities increased substantially for lower brackets.

Despite a decade characterized by the 'farm-fish debate,' by the 2060's both farm and fish are largely gone from the Basin. Except for a handful of upland specialty farms, agricultural production has ceased in the Snohomish Basin. As flood frequency increased, it simply did not make financial sense to repair failing levees and then utilize the land for food production, especially as the soil was so heavily contaminated during flood events. The longer growing season did facilitate the rise of new hobby farms, typically run by retired professionals with a disposable income, but few were economically viable. By the 2060's Chinook and Bulltrout are officially extinct from the Basin. The laundry list of restoration projects fell to the side as more pressing social concerns dominated agency budgets and political interest. In the flurry of flooding, redevelopment and deregulation, streams were so degraded there was little left to save. The other wild stocks, while still present and monitored, are struggling to survive.

Over the years conflict arose with a several minority populations within the Basin. Nowhere was it as powerful as the conflict with the Tulalip Tribes. After decades of struggling to implement proactive restoration and mitigation policies, the Tulalip Tribes filed a multi-billion dollar Boldt 2 lawsuit over the loss of loss streamflow protection for sustainable water supply and fish stocks. While receiving financial compensation, the Tribe never regained their traditional livelihood leading to the loss of tribal heritage and strained relationships with their Basin neighbors.

Metamorphosis

Early in the century, the Puget Sound won a long fought battle: equal bargaining power for the environment. The major power brokers of the Region woke to a mandated epiphany centered on full accounting of ecosystem services, fast-tracking projects that support resiliency and financial incentives for projects that emphasize transparency and collaboration. While the next fifty years were fraught with intense climatic shifts, numerous errors, and hot political debates, the majority of economic, social and environmental progress indicators reflected positive change.

Climatic changes were evident throughout the Basin. Year after year the Region was faced with record breaking events, from intense precipitation periods to heat waves and strong winds. Higher elevations lost the majority of their snowpack by early spring, leading to more frequent winter floods and declining baseline flows. Stream temperatures rose, as did levels of toxins and pollutants carried by urban streams. Salmon stocks declined and many feared population numbers would not rebound. However, each new challenge was transformed into a learning opportunity, and chance to correct past errors. Empowered public agencies prioritized innovative and integrated strategies that focused on supporting flexibility through buffers, diversity and inter-agency monitoring.

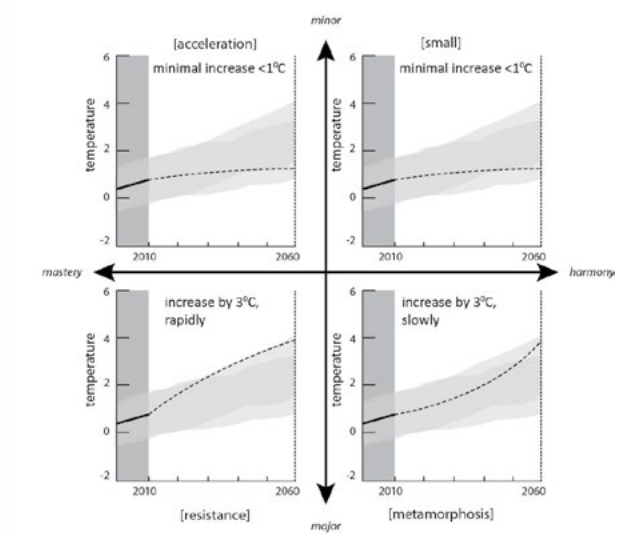
Over the years, the Basin's historical geomorphology and land cover served as a guide to relocate and redesign patterns of development. When major floods destroyed aging levees, restructured new 'softer' levees were set back and riparian buffers were re-vegetated. With each new flood the Basin regained its hydrological connectivity, reducing flood impacts in consequent decades. Meanwhile, agricultural incentive districts subsidized farms that promoted sustainable practices by insuring harvests from flood damage (i.e. pay for flooded crops). Upland, private timber companies were paid to not harvest and financially encouraged to seek alternative environmentally sustainable forest initiatives. Several non-profit organizations collaborated with government agencies to support smaller land owners, representing the fastest growing sector of resource managers. These organizations provided small forest and natural lands owners with a network of free scientific expertise and volunteer laborers that promoted diverse and healthy forestlands while performing County audits.

The pressure to grow continued to be one of the toughest challenges for the Basin. The word was out; the Region was a global magnet, a great place to live, work and play. The Basin continued to boast abundant accessible natural lands just a short distance from several metropolitan centers, outpacing Pierce and King Counties for new jobs and migrations. Growth was tightly funneled into urban corridors as directed by the GMA. Denser clusters of diverse jobs and housing facilitated investments in more efficient and adaptive infrastructure. However, the cost of permitting rose substantially and many companies were priced out of developing in the Basin. While real estate values skyrocketed, affordable housing quotas forced developers to allocate 25% of all new housing to lower income households. Cities like North Bend, Monroe and Snohomish doubled in size, boasting diverse neighborhoods with unique cultural,

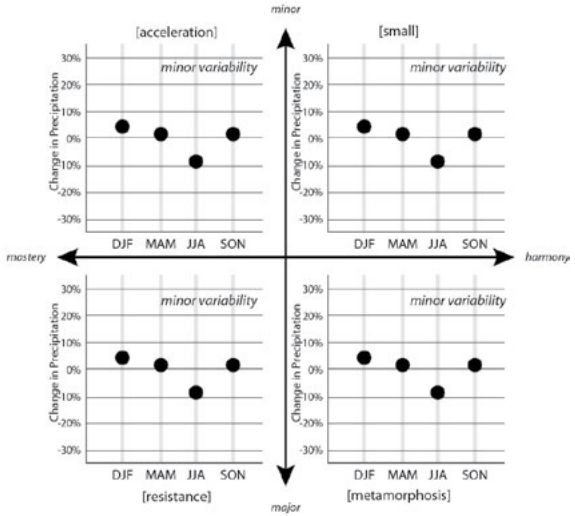
business and natural amenities. Smaller cities, further east, also grew, serving as Regional outdoor recreation hubs with industries built around seasonal tourism.

Technological advancements fundamentally altered people's mobility, lifestyle choices and socio-economic networks. Vanpools ferried people across the Basin utilizing live geotracking to serve emergent clusters of commuters. Many region-based 'green-energy' technologies came online, from wind turbines to in-stream microturbines, affordable solar panels to methane digestion and biofuels. While the business side of innovation spurred economic growth, ecologically the majority of projects failed to meet intended goals. The most significant improvements stemmed from a highly accessible localized indicators platform, which supported household decision making, from what produce to buy, to needed water conservation measures and public health alerts. While some improvements facilitated better knowledge sharing and proactive management, the abundance of available information and an over-reliance on synthesized data were criticized by many as leading to a loss of natural response mechanisms and significant blind spots.

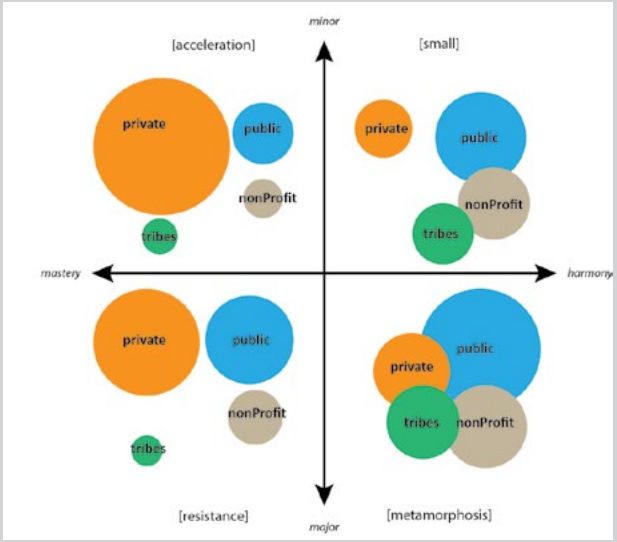
Over the years, social norms embraced more equitable and long term investments, which radically altered the Region's response to novel challenges. While the size and power of the public sector grew, institutional frameworks changed to be more adaptive and flexible, yet demanding. The cost of living in the Basin grew significantly within rising taxes and regulatory overhead as many new social programs and large scale infrastructure investments were made. Public provision of public health, education, unemployment assistance, child care, assisted-living, public transportation and open space took a significant toll on industry and household budgets. Over time, economic burdens were boasted as redistributive and egalitarian. As natural hazards, emerging diseases, economic crises, and protests occurred, the duration and intensity of emergencies were dampened by the strong partnerships, flexible institutions, wide buffers and diverse hybrid social-ecological system in place.



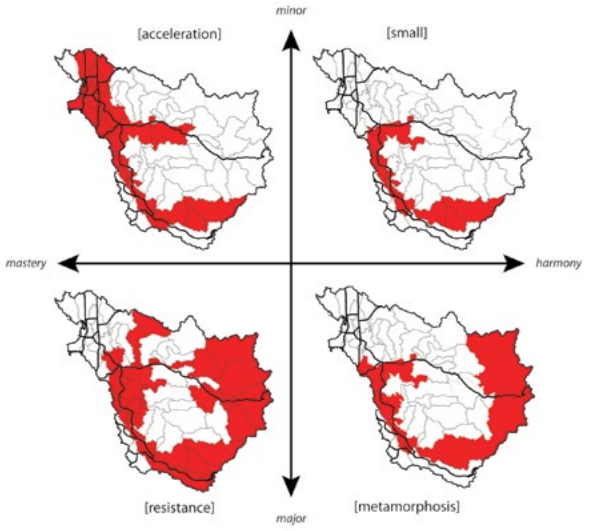
Annual Temperature Change



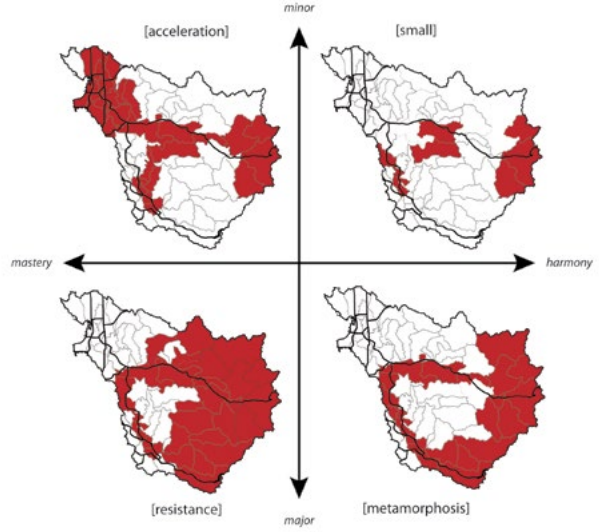
Seasonal Precipitation Variability



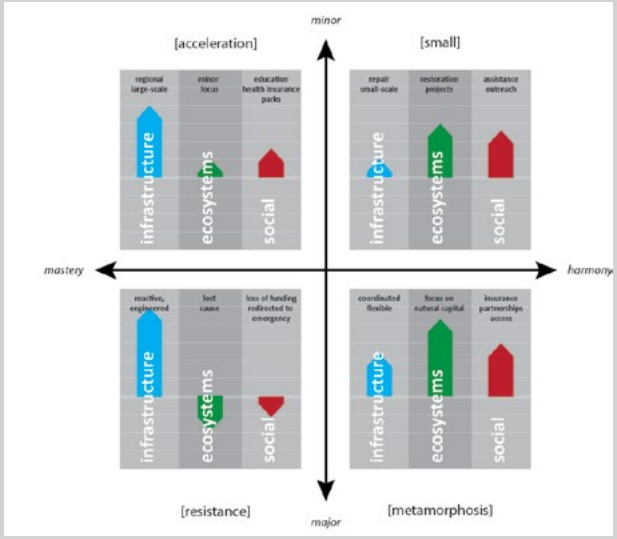
Actors



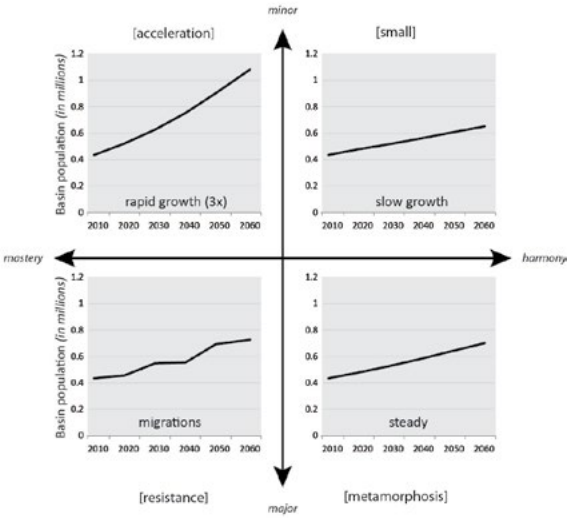
Maximum Stream Temperatures



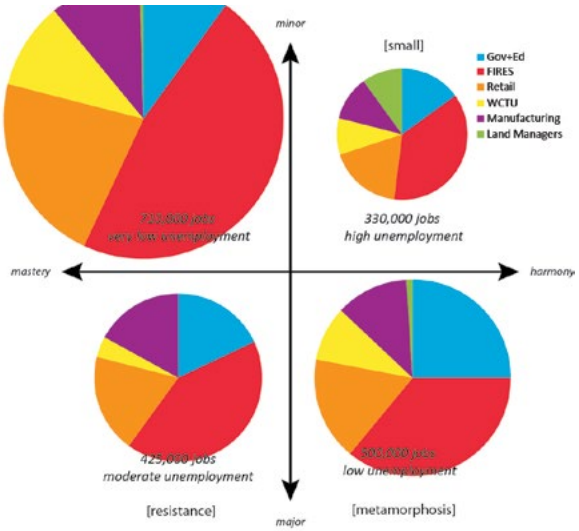
Change in Minimum / Maximum Flows



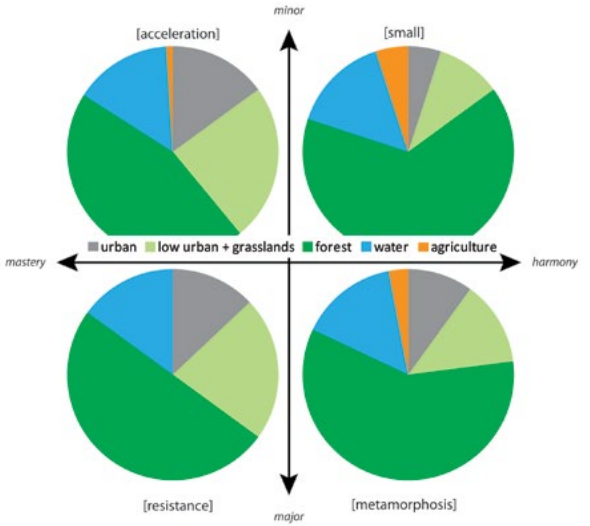
Investments and Approval Ratings



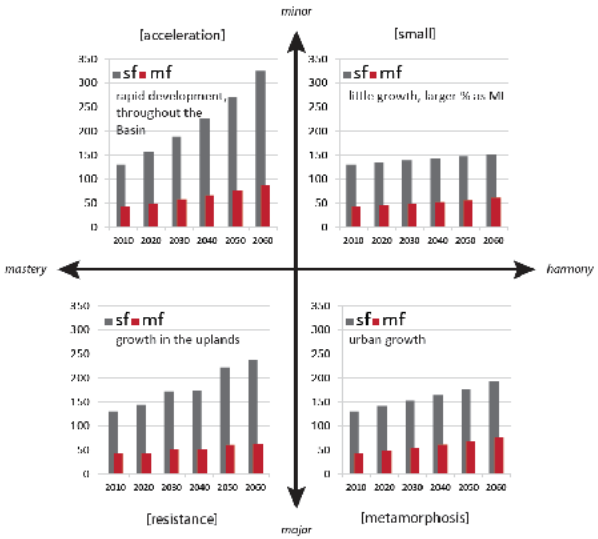
Population Growth



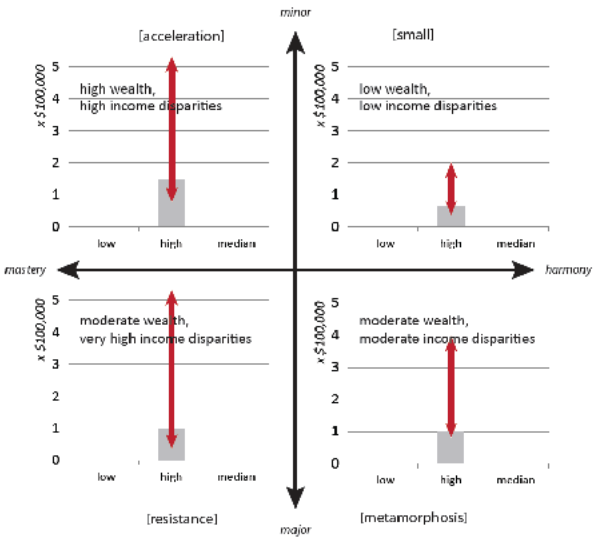
Jobs by Sector



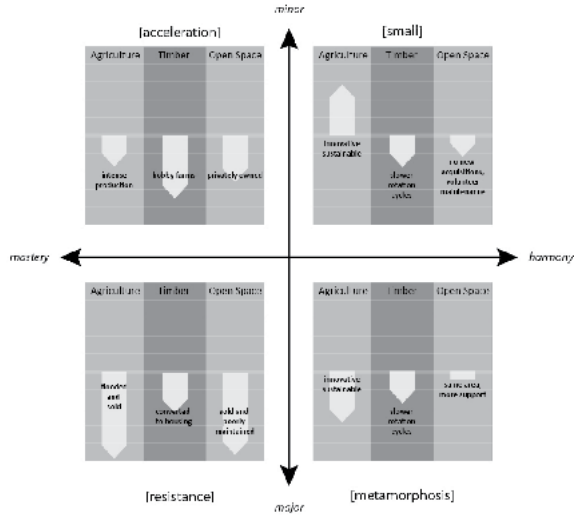
Land Cover



Building Perrmits



Wealth Disparities



Resource Management

Policy Workshop

What are the critical decisions facing the Snohomish Basin over the next 50 years?

UERL. Feb 24 2012

Agenda

9:00-9:30	Introductions
9:30-11:15	Exercise: Decisions under Uncertainty
11:15-11:25	Coffee Break
11:25-12:00	Plenary Discussion. How to Make Better Decisions
12:00-1:00	Lunch and Presentation by UERL team
1:00-2:00	Team Discussions. Identifying Critical Decisions, Actors and Strategies
2:00-2:30	Team Presentations
2:30-2:40	Coffee Break
2:40-4:00	Team Discussions. Risks, Trade-offs, and Policy Evaluation
4:00-5:00	Plenary Discussion. Redefining the Problem: What questions should we ask?

INTRODUCTIONS

Scenarios for Snohomish Basin 2060

- Develop an assessment of key ecosystem services in the Snohomish Basin by characterizing the uncertainty associated with alternative future baseline conditions.

a 2-year research agenda

Funded by the Bullitt Foundation

Snohomish 2060 Scenario project

Project Objective:

- *develop a synthesis of what we know*
- *integrate diverse perspectives*
- *challenge assumptions about the future*
- *inform development of management strategies*

Making Better Decisions: Myths

- Eliminate uncertainty
- Remove differences
- Have complete knowledge
- Have plenty of resources
- Achieve perfect coordination

….. Probably there was no decision to be made

Making Better Decisions: A Hypothesis

- Embrace uncertainty to build robust decision
- Build on differences to explore opportunities
- Use information to test what we know
- Exploit resources to maximize benefits
- Transform redundancy into partnership

Workshop Objective

Explore how Scenario Planning can expand our decision framework by:

- *Challenging our assumptions*
- *Accounting for uncertainty*
- *Identifying risks and opportunities*
- *Prompting new questions*

Simulation

- *Four Scenarios*
- *Decision Context*
- *Exercise*
- *Discussion*

9:30-11:15

DECISIONS UNDER UNCERTAINTY

instructions

- You are a member of a task force aimed at protecting the long term watershed function in the Snohomish Basin.
- Represent yourself
- The EPA has committed to fund three projects within the next twelve months to help meet your goals.
- Select and agree on 3 strategies
- Material: strategies, indicators, current state and forecasts, dashboard implications of selection

9:35-9:45

STEP 1: REVIEW MATERIAL

9:45-10:15

STEP 2: SELECT AND AGREE ON 3 STRATEGIES

10:15-10:35 Review Scenarios
10:35-11:05 Select and Agree on 3 Strategies
11:05-11:15 Reflect

STEP 3: THE SCENARIOS

11:15-11:25

COFFEE BREAK

11:25-12:00

PLENARY DISCUSSION: HOW TO MAKE BETTER DECISIONS

How to make better decisions

- How did you choose the 3 strategies? What criteria did you use for selecting them?

How to make better decisions

- How did you choose the 3 strategies? What criteria did you use for selecting them?
- How did you take uncertainty into account in the decision making process?

How to make better decisions

- How did you choose the 3 strategies? What criteria did you use for selecting them?
- How did you take uncertainty into account in the decision making process?
- How did the information provided differ from your everyday decision making process?

How to make better decisions

- How did you choose the 3 strategies? What criteria did you use for selecting them?
- How did you take uncertainty into account in the decision making process?
- How did the information provided differ from your everyday decision making process?
- What additional insight do scenarios provide?

12:00-1:00

LUNCH AND PRESENTATION

Bob Burns, *King County*
Nicole Faghin, *AECOM*
Jim Franzel, *USFS MB-S*
Judy Herring, *KC Farmland*
Abby Hook, *Tulalip Tribes*
Alice Kelly, *Dept. of Ecology*
Brent Lackey, *Tolt Watershed*
Jim Miller, *City of Everett*
Philip Popoff, *PSE*
Chris Raezer, *City of Arlington*
Morgan Schneidler, *PSP*
Dave Somers, *Snohomish County*
Brett Swift, *American Rivers*
Tim Walls, *the Forum*
Daryl Williams, *Tulalip Tribes*

Steering Committee

July 2010

▪ the Project

Steering Committee Directives, July 2010

- Additional Questions
- Opportunities and Challenges
- Priority Actions
- Decisions through Actors
- Integrate Multiple Perspectives
- Build on Existing Works
- Articulate Current and Future Baselines
- Validate Ideas

▪ the Project

Steering Committee Directives, July 2010

- Additional Questions
- Opportunities and Challenges
- Priority Actions
- Decisions through Actors
- Integrate Multiple Perspectives
- Build on Existing Works
- Articulate Current and Future Baselines
- Validate Ideas

▪ the Project

A 2.5-year Research Agenda

Year 1: Defining the Problem

- Build a Science Team
- Identify drivers of change
- Develop a conceptual model
- Compile data on current status and past trends

Year 2: Alternative Plausible Futures

- Important and uncertain drivers
- Scenario logics
- Forecasts and predictions
- Model integration
- Assessment of alternative trajectories
- Narratives

Year 2.5: Evaluate Implications

- Indicators of Ecosystem Services
- Opportunities and Challenges
- Basin Actors and Approaches
- Interactions with Potential Strategies

▪ the Project

State of the Basin 2010

DEFINING THE PROBLEM

Norm Abbott
Jackie Aitchison
Marina Alberti
Sue Ambler
Dom Amor
Stanley Asah
Elaine Babby
Krista Bartz
David Batker
Kurt Beardslee
William Beyers
Bob Bilby
Christopher Bitter
Michael Blake
Heidi Bohan
Leah Bolotin
Brandon Born
Alan Borning
Ann Bostrom
Mark Boyer
Nicholas Bratton
David Buerge
David Burger
Bob Burns
Ann Bylin
Ken Carter
Paul Byron Crane, B.L.A., M.A.
Sara Curran
Curtis DeGasperi
David Dilgard
Mary Embleton
Gina Estep
Nicole Faghin LEED AP
John Findlay
Jim Franzel
John Gamon
Simon Geerlofs
Bonnie Geers
Jamie Glasgow
Andy Hall
Troy Hall
Alan Hamlet
Chris Harvey
Kelly Heintz
Ryan Hembree
Jan Henderson
Judy Herring
Kollin Higgins
Abby Hook
Peter Jackson
Jennifer Jerabek
Janne Kaje
Kristin Kelly
Alice Kelly
Michael Kern
Karen Kinney
Jacque Klug
Bill Knutson
Deborah Knutson
Dave Kosciuk
Brent Lackey
Steve Kiss
Donnie LaTourrette
Roberta (Bobbi) Lindemulder
Sandra Mallory
Mike March
Stewart Mathieson
Matt Mattson
Mark Maureen
Heike Mayer
Doug McClelland
Al McGuire
Phyllis Meyers
Marcia Meyers
Anna Miles
Jim Miller
Barbara Mock
Dave Montgomery
Scott Moore
John Moore
Tom Niemann
Tom O'Keefe
Mike Patterson
Dave Peterson
Chris Picard
Patrick Pierce
Philip Popoff
John Postema
Scott Powell
Chris Raezer
Kit Rawson
Dave Redman
David Remlinger
Luke Rogers
Mary Rucklehaus
Michael Rustay
Eric Salathe
Rowan Schmidt
Morgan Schneidler
Howard Schwartz
Mark Simonson
Amy Snover
David Somers
Cindy Spry
Stephen Stanley
Don Stuart
Ralph Svrjcek
Brett Swift
Jim Teverbaugh
Dan Tonnes
Joe Tovar
Mike Town
Stacy Trussler
John Ufford
Anne Vernez Moudon
Elizabeth Walker
Tim Walls
Elizabeth Weldin
Richard White
Jan Whittington
Matt Wiley
Terry Williams
Daryl Williams
Clark Williams-Derry
Kathy Wolf
Hendrik Wolff
Ken Yucom
Yi Zhao
Ken Zweig

our Science Team

▪ the Project

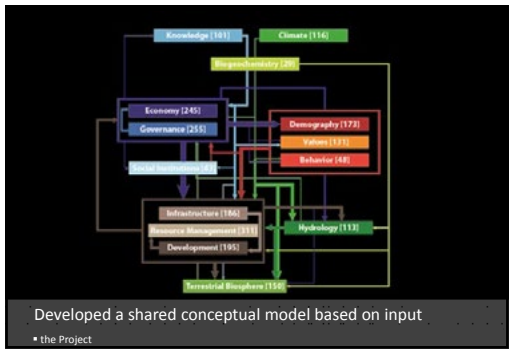
Interviewed 64 science team members and asked them:
How will the Basin change over the next fifty years?

▪ the Project

Drivers →	Behavior	Demography	Values	Economy	Governance	Knowledge	Social Institutions	Development	Infrastructure	Resource Management	Biogeochemistry	Climate	Hydrology	Terrestrial Biosphere
Behavior	48	1		1	4			4	3	5			1	2
Demography	1	173	7	13	24	4	8	44	25	15		2	3	2
Values	6		131	23	25			9	35	15	42			6
Economy	7	44	6	245	19	1	12	61	39	65		2	8	1
Governance	5	36	2	56	255	7	6	75	41	60	1	2	12	18
Knowledge	6	3	14	12	16	101	0	0	20	24	2	2	3	8
Social Institutions	3	3	6	11	19	6	83	7	1	15				4
Development	1	15	5	16	22		1	195	75	48	2	2	10	8
Infrastructure		3	4	22	14		4	42	186	34	2	2	18	21
Resource Management		8	14	18	24	4	6	9	10	311	3		21	33
Biogeochemistry		2		2				5	5	3	29	1	8	6
Climate	8	4	2	4	9	1	1	8	30	18	4	116	34	37

Synthesized interview transcripts and models by grouping drivers and relationships between them

▪ the Project



Developed a shared conceptual model based on input

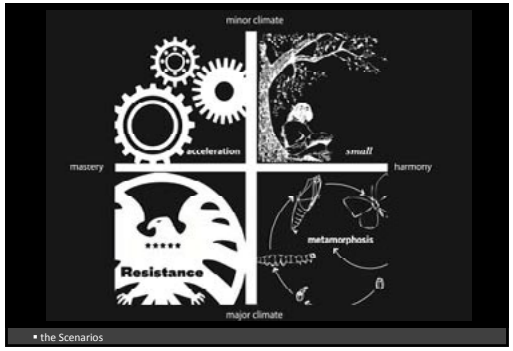
▪ the Project

Compiled data on status and past trends of key drivers

▪ the Project

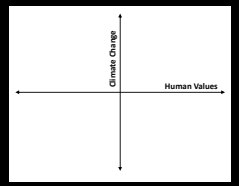
State of the Basin 2060

THE SCENARIOS



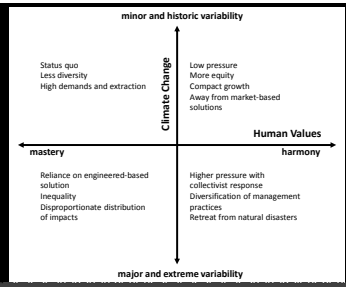
▪ the Scenarios

Driver	Votes
Demographics	4
Behavior	5
Values	11
Economy	6
Governance	
Social Institutions	2
Knowledge	
Development	4
Infrastructure	
Resource Management	
Hydrology	1
Climate	12
Terrestrial Biosphere	5



Identify the most important and uncertain drivers

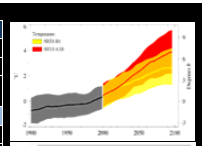
▪ the Scenarios

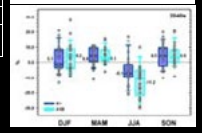


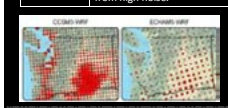
Scenario Development Team selected variables and initial hypotheses

▪ the Scenarios

Major Change	
IPCC Scenario	A1B
Temperature	3.5degC increase by 2060
Variability	Extreme events, exaggerated seasonal variability
Minor Change	
IPCC Scenario	B1
Temperature	1.5degC increase by 2060
Variability	Historical variability. Hard to detect change from high noise.







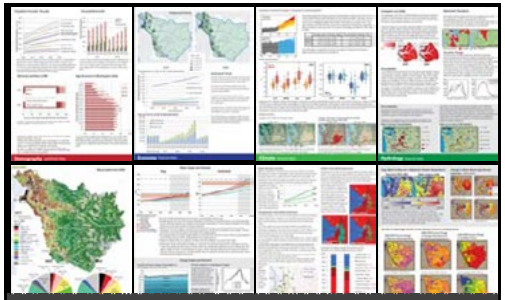
Selected Climate Change variables: magnitude and variability

▪ the Scenarios

Variable	Mastery
Relationship to natural and social world	master and change the world, to assert control, bend it to our will, and exploit it in order to further personal or group interests.
Cultural emphasis	*Getting* ahead through active self-assertion .
Keywords	ambition, success, daring, competence
Variable	**Harmony**
Relationship to natural and social world	accept the world as it is, trying to fit in rather than to change or exploit it.
Cultural emphasis	*Fitting harmoniously into the* environment .
Keywords	protecting the environment, equity

Selected human values variables: mastery vs. harmony

▪ the Scenarios



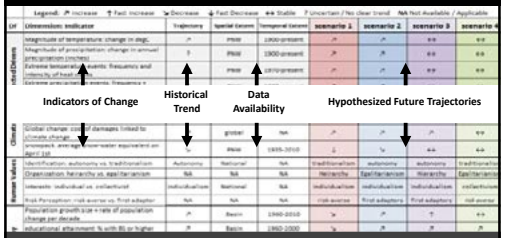
Collected forecasts and predictions for the region

▪ the Scenarios

Brought modelers together to draft an integrated model

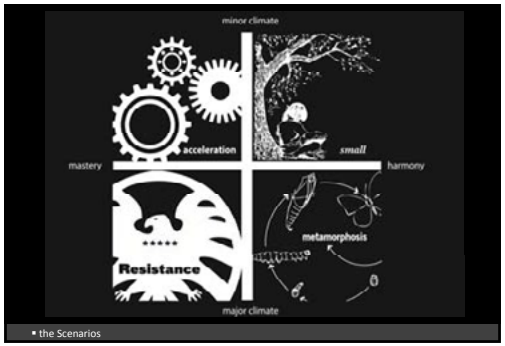
▪ the Scenarios

Scenario Trajectories

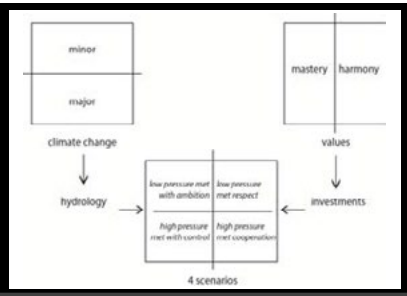


Tested potential future trajectories with Science Team

▪ the Scenarios

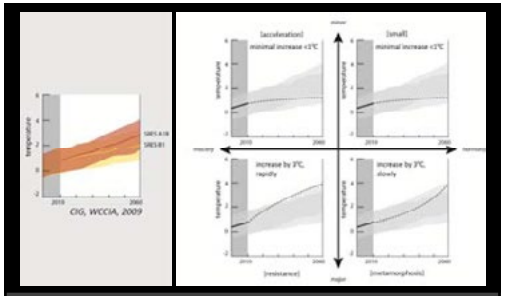


▪ the Scenarios



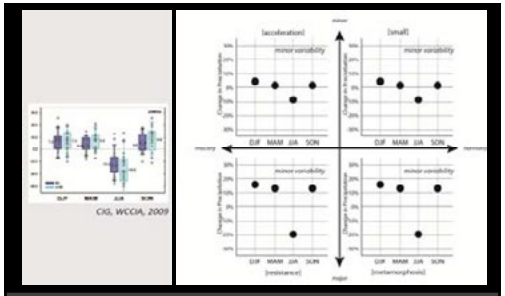
crossing the drivers

▪ the Scenarios



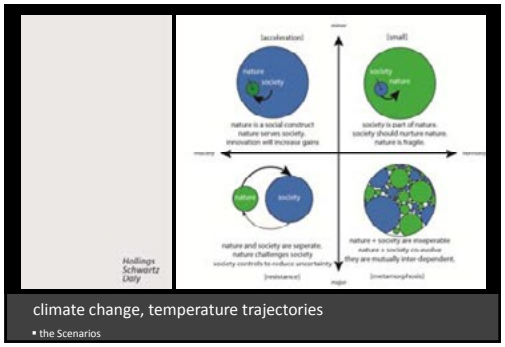
climate change, temperature trajectories

▪ the Scenarios



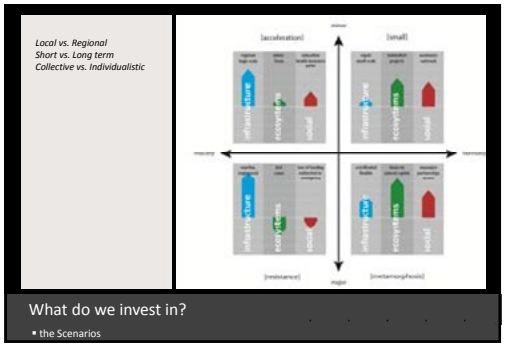
climate change, precipitation seasonal variability

▪ the Scenarios



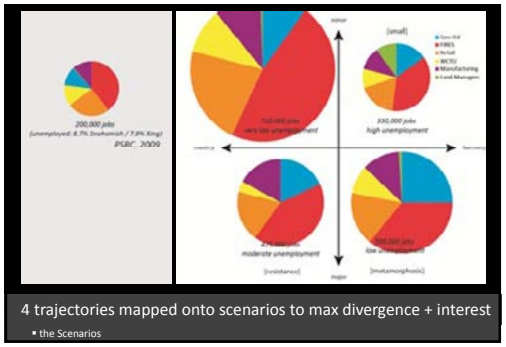
climate change, temperature trajectories

- the Scenarios



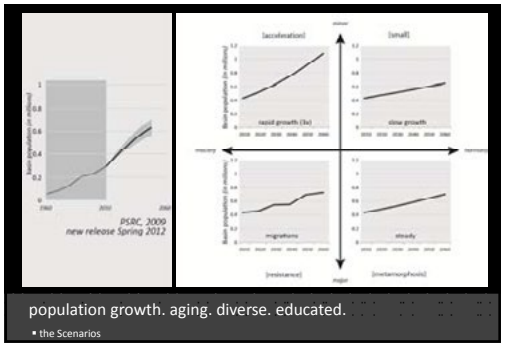
What do we invest in?

- the Scenarios



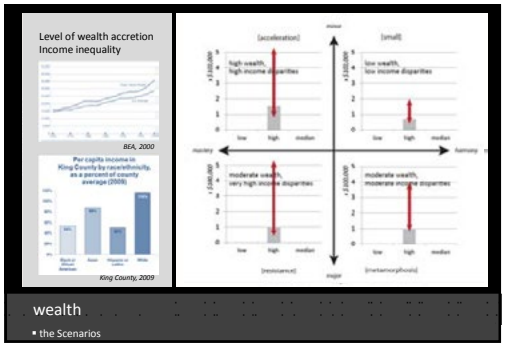
4 trajectories mapped onto scenarios to max divergence + interest

- the Scenarios



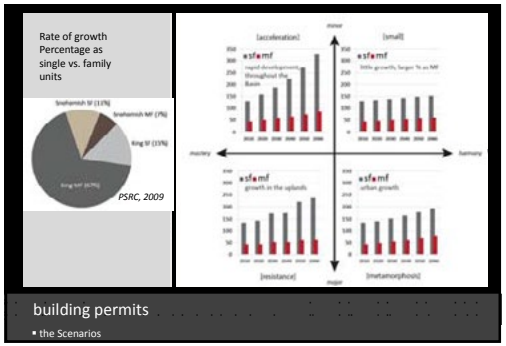
population growth. aging. diverse. educated.

- the Scenarios



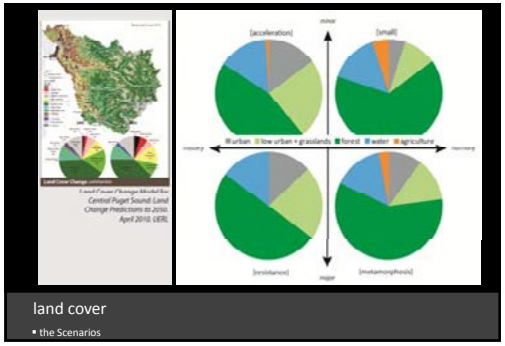
wealth

- the Scenarios



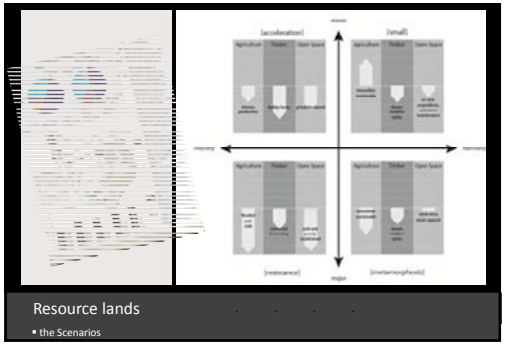
building permits

- the Scenarios



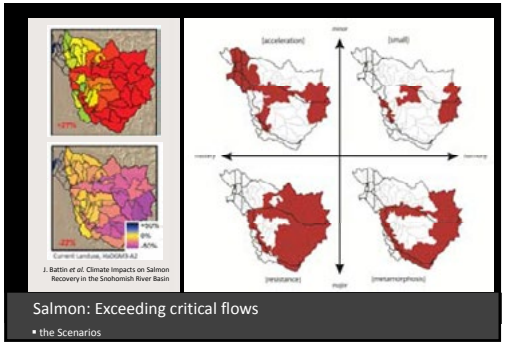
land cover

- the Scenarios



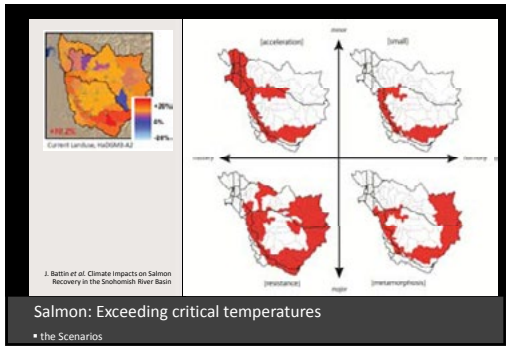
Resource lands

- the Scenarios



Salmon: Exceeding critical flows

- the Scenarios



Salmon: Exceeding critical temperatures

- the Scenarios

Who are the actors? What are the relationships between them?

- the Scenarios

Indicators of Ecosystem Services
Opportunities and Challenges
Basin Actors and Approaches
Interactions with Potential Strategies

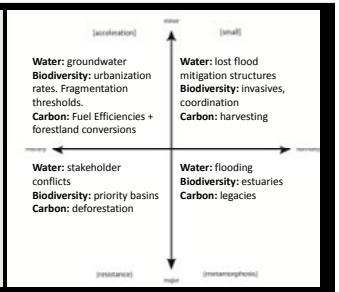
EVALUATING IMPLICATIONS

Indicators of Ecosystem Services

- Evaluating Implications

Across the Scenarios..

- Water quality
- Water quantity
- Species biodiversity
- Landscape biodiversity
- Carbon stocks
- Carbon fluxes



Water: groundwater **Biodiversity:** urbanization rates. Fragmentation thresholds. **Carbon:** Fuel Efficiencies + forestland conversions

Water: lost flood mitigation structures **Biodiversity:** invasives, coordination **Carbon:** harvesting

Water: stakeholder conflicts **Biodiversity:** priority basins **Carbon:** deforestation

Water: flooding **Biodiversity:** estuaries **Carbon:** legacies

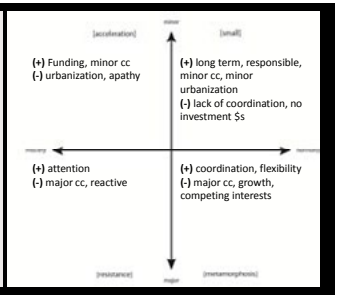
Are the implications of indicator trajectories linked to strategies?
What are measures of resilience?
How do we prioritize across indicators?
Which indicator gives us enough warning to change strategies?

INDICATORS

WHAT ARE THE KEY OPPORTUNITIES AND CHALLENGES?

Unique to the Snohomish Basin and Region?

Challenges we heard about...
global and local climate change
growth and funding
age structure and development patterns
flood protection and farms
working and protected forests



(+) Funding, minor cc
(-) urbanization, apathy

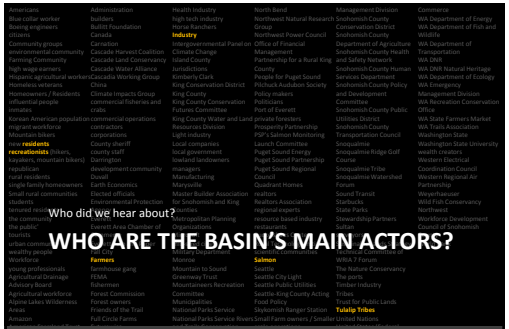
(+) long term, responsible, minor cc, minor urbanization
(-) lack of coordination, no investment $s

(+) attention
(-) major cc, reactive

(+) coordination, flexibility
(-) major cc, growth, competing interests

Opportunities and challenges

- the Scenarios



Who did we hear about?

WHO ARE THE BASIN'S MAIN ACTORS?

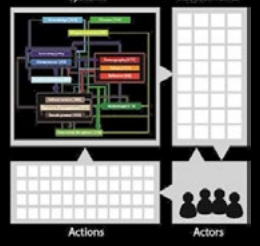
- Evaluating Implications

Actions we heard about…

WHAT ARE TODAY'S ACTIONS

▪ Evaluating Implications

Decision Framework



▪ Evaluating Implications

WHO WILL BE THE ACTORS IN 50 YEARS?

How will their perspectives shift? Who will win? Who will lose?

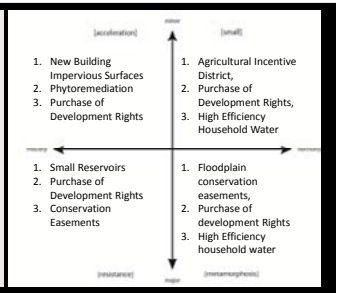
▪ Evaluating Implications

Evaluating robustness

SCENARIO INTERACTIONS WITH POTENTIAL STRATEGIES

▪ Evaluating Implications

- Small Reservoirs
- Purchase of development rights in Upland Forests
- Floodplain Conservation Easements
- New Building Impervious Surfaces
- Water tax
- Phytoremediation wetlands
- Agricultural incentive District
- High Efficiency Household Water



Alternative future conditions support alternative decision options

▪ the Scenarios

1-2 Team discussion - Identifying Critical Decisions, Actors and Strategies

AFTER LUNCH

1:00-2:00

TEAM DISCUSSION - IDENTIFYING CRITICAL DECISIONS, ACTORS AND STRATEGIES

Instructions

- Re-divided by number on nametags
- Small group discussions on key topics
- Handout of discussion questions at each table
- ~10 minutes per question
- Meet back at 2:30pm for short team presentation of findings.
- Please select a note-taker in the group and a presenter
- Presentations should synthesize key ideas. 5 minutes per team.

Discussion Questions

- What are critical decisions facing the Snohomish basin over the next 50 years?
- What are key uncertainties?
- What are the alternative strategies (options)?
- Which indicators should we monitor to evaluate success?

2:00-2:30 five-minute per team

TEAM PRESENTATIONS

2:30-2:40

COFFEE BREAK

2:40-4:00

TEAM DISCUSSION – RISKS, TRADEOFFS AND POLICY EVALUATION

Instructions

- Re-divided by color, same as initial teams
- Small group discussions on key topics
- Handout of discussion questions at each table
- ~30 minutes per question
- Please select a note-taker in the group

Discussion Questions

- What are potential trade-offs of alternative strategies across the 4 scenarios?
- Which strategies might be most robust (effective across all four scenarios)?
- How do we evaluate success?

4:00-5:00

PLENARY DISCUSSION: REDEFINING THE PROBLEM. WHAT QUESTIONS SHOULD WE ASK?

Defining ecosystem service provision in the face of uncertainty

WHICH DECISIONS ARE MOST SENSITIVE TO CHARACTERIZED UNCERTAINTY?

What questions should we be asking?

HOW DO WE EVALUATE STRATEGIES?

Gap analysis

WHAT DO WE NEED TO KNOW?

IS ADAPTATION SUFFICIENT TO ACHIEVE DESIRABLE CONDITIONS?

How do we generate transformation?

HOW DO WE DEFINE WHAT IS DESIRABLE?

Synthesis

10 directives for making decisions under uncertainty

1. Does this strategy improve the resiliency, or ability of the system to withstand change?
2. What are the opportunity costs if we do not implement this strategy? If we implement it later? What are the tradeoffs in comparison to other options?
3. Does this strategy improve on the current diversity of approaches, spatial allocations, and goals?
4. What are the ecological, economic and social distributions of impacts, across time and space and actors associated with this strategy?
5. At what indicator levels do we change the strategy because of critically close thresholds or because we have achieved acceptable standards?
6. Does this strategy facilitate our capacity to learn, or institutional long-sightedness?
7. How does this strategy overlap existing actions and networks to support a thick and redundant response?
8. Does this strategy build on natural processes?
9. Is this strategy robust, aimed at improved benefits across plausible futures or optimal, effective under a predefined set of conditions?
10. How does this strategy leverage linkages between stakeholders and tradeoffs to meet multiple needs through fewer resources?

EXERCISE 1: decisions under uncertainty

A. In an exercise focused on decision making under uncertainty, workshop participants were asked to select 3 of 8 pre-defined strategies to improve long-term watershed health in the Snohomish Basin. The options included: small reservoirs, Purchase of Development Rights (PDR), floodplain conservation easements, low impact development restrictions (LID), water tax, Phytoremediation wetlands, agricultural incentive district, high-efficiency water fixture incentives. Click her for the full instructions including description of strategies. Teams 1-4 ***selected these strategies,*** respectively:

- PDR, Phytoremediation, agricultural incentive
- PDR, floodplain conservation easement, LID
- PDR, LID, Agricultural incentives
- PDR, floodplain conservation easements, LID

B. Participants made the following ***observations*** about the given strategies:

- PDR: restricts harvesting. Already in place, not really utilized. Ideally also TDR and also include Ag.
- Small reservoirs: release warm water (because of season in which it is needed). Too expensive, hard to permit.
- Floodplain conservation easement: agricultural challenges, off the table (?).
- LID / New building impervious surfaces: where will this impact water? Benefit to Sound pollution, not upland runoff. Supports mix of land uses. Efficacy dependent on soil and infiltration capacity.
- Water tax: requires stepped pricing based on household use. Unpopular, don't do much.
- Agricultural incentive: Is Ag incentive better than floodplain conservation? You need to focus on the trust of farmers, and involve everyone. Good because it encourages mix of land uses. Should include riparian restoration.
- Phytoremediation wetlands: skeptical. Do they function? How long? Better to improve hydrologic function via restoration.

- High efficiency water: the market is already handling this for industrial and commercial. Not a lot of new development, and retrofitting isn't choosing high efficiencies.

C. What were your ***criteria*** for selecting the strategies? What do you watch (factor / trend) in decision making?

- Most effective, based on knowledge
- Practical
- Implementable
- Greatest spatial reach
- Prioritize / take advantage of natural processes over technical solutions
- What is the scale at which these strategies are implemented?
- Need to integrate forest and agricultural lands together (look at whole Basin)
- Group interests and dynamics
- What are the expertise around the table
- Balance environmental and economic viability

D. How did you take **uncertainty** into account in the decision making process?

- Looked at strategies that work across agricultural, open space and urban lands.
- Lower risks by diversifying. Spread the involvement / risk
- Making the system more resilient
- Monitoring is key. What is the strength of adaptive management? What are the warning signals?
- What is the role of self-awareness? How susceptible is the system to learning?
- Asking what is robust vs. optimized.
- What is the consequence of acting / not acting?
- What are the indicators representing variability?
- What is irreversible? What are critical thresholds?

E. What additional ***insight*** do scenarios provide?

- Scarcity: Resource allocation
- Flexibility / adaptability (e.g. reservoirs require a lot of $$ but uncertain effectiveness, less adaptable)
- What are we trying to protect? – be clear
- Limitation of presented scenarios:
- Feedback – can we change the scenarios?
- What is desirable? Visioning needed. All scenarios seemed like terrible worlds.
- No buy-in or trust in these scenarios.
- Risks – precautionary principle
- Acceptable vs. unacceptable uncertainty
- Drivers are not static, but rather shifting.

AFTER LUNCH DISCUSSION

Workshop participants divided into two teams and discussed 5 themed questions reflecting on long term decision making in the Snohomish Basin. Below are the captured notes from the discussion.

A. What are ***critical decisions*** facing the Snohomish basin over the next 50 years?

- (T1) where to put everybody, how to put everybody
- (T1) feeding people
- (T1) maintaining socio-ecological integrity
- (T1) not enough water
- (T2) Managing resource lands in the face of development, demographics, and economics
- (T2) Investment in restoration
- (T2) Regulatory stringency
- (T2) Investment in knowledge and predictive power

B. What are key ***uncertainties***?

- (T1) technological age / values, unanticipated consequences
- (T1) Streamlining permitting, eliminating inconsequential requirements
- (T1) Renewable energy
- (T2) Degree of climate change
- (T2) Ecological thresholds
- (T2) Economic trends
- (T2) Institutional stability and policy direction (vs. short sightedness)

C. What are potential ***opportunities and risks***?

- Team 1
- (+) knowledge to participate in ecological recovery. Institutional capital and foundation.
- (+) Undeveloped land – choices to make, ability to learn from others.
- (-) risk of mis-investment
- (+) Incentivizing ecosystem services
- (-) sense of entitlement by resource owners, self perpetuating.
- (+/-) Maintaining or losing cultural moral sense.
- (+/-) Values of younger generation

D. What are the ***alternative strategies*** (options)?

Team 1:

- Increase blending (e.g. Sustainable lands strategy)
- Reservoir – opportunities and challenges associated with sovereignty
- Buy in- across scales
- Redundancies – a good thing
- coordination

Team 2:

- All the usual suspects (regulatory, market, voluntary)
- Integrated
- Co-created / actor
- Not single goal
- Spatial

E. Which ***indicators*** should we monitor to evaluate success?

- (T1) Sensitivity of indicators to changes in the system
- (T1)Indicators representing values (low flows, water quantity for fish, drinking water, etc.)
- (T1) Full spectrum of indicators (social indicator, e.g. income disparities)
- (T1) Long term indicators to keep track of where we are headed.
- (T2) something, make sure it's linked to decision making.
- (T2) responsible, set of broad directly measureable indicators of whole system health.
- (T2) specific measureable outcomes we care about (responses) (e.g. certain valuable species).
- (T2) distinguish between what's influential and what's not (need both)
- (T2) triple bottom line. +4th, health. Integrated.

WRAPUP

A. Redefining the problem. What questions should we ask?

- Limits of adaptive management, irreducible uncertainty
- Learning and capacity to change
- Powerful outcome if represents perspectives of current community
- Scenarios too cartoony
- Triple bottom line
- Interface of opportunities (health)
- How flexible is it?
- Outcomes, how can we measure its efficacy?
- What are the thresholds?
- What are we satisfied with?
- Linkages (e.g. how will the legal world of 'neighbors' change?)
- Biophysical, legal, moral, human dimensions
- Distributional consequences
- Take out to broader scale
- Redefine our community
- How complexity can influence decision making – fast context
- Seed planting (how ideas take root)
- Benevolent dictator (leadership)
- 80% choice 20% out of control

B. How do we know what is desirable?

- Trust, capacity of society to transform
- Participatory approach 'on crack'
- Scenarios can help describe the outcome of paradigms over time, then read in terms of implications on personal (and collective) desires
- Historical conditions with moderate variation
- Broad socio-economic health
- Multi-dimensional, messy scenarios (good)
- How are my desires challenges by alternative paradigms?
- Does the desirable shift?
- False equivalency of indicators

Steering Committee Review

Date

8.7.2012

Location

Gould Hall. UW, Seattle.

Objective

To recieve feedback on the Final Report and define next steps for how to effectively share project lessons.

Attendance

Steering Committee members

Agenda

Presentation on final report.

Questions and answer session on findings and overall process

Steering Committee feedback on the report

Discussion of next steps

Materials

(draft final report)

Discussion questions:

Plausible Scenarios

- Are these four scenarios plausible?
- How do they differ from your previous/current view of the future?
- What do they add? Are there surprises?
- What are some missing elements?

Decision Making

- How do the scenarios expand the current decision framework of your organization?
- How can they help your agency make robust decisions to protect ecosystem services?
- How can they help the Snohomish community generate creative solutions to current challenges?
- How can they help the region adaptation to environmental change?

Communication

- Does the report provide a compelling story about the scenarios?
- Is the report well documented and clear?
- Can you provide a specific example in the report of effective communication?
- Is there any specific element and/or information missing?
- What would help to make the report more effective?

Scenarios: Next Steps

- How might the Snohomish Basin Scenarios be used in practice?
- How can we best share/present this information to these actors?
- Did you learn any insight from the Scenario process?
- What can we learn from this experience to lead the next scenario process?

Synthesis

We had some great input into how to streamline the final report by 1) highlighting findings for decision support and 2) providing practical examples.

Plausible scenarios **>** the scenarios and their logics should be vetted with the Science team.

Decision Making **>** use specific example to ground the theoretical ideas in regional applicaitons. An integrated model would be a complement to this exercise to test some of these ideas.

Communication **>** The report is too long for most decision makers to utilize. Put the analysis and backgorund into appendices. Highlight the scenarios and the lessons learned.

Next Steps **>** It would be great to have a meeting in Everett with diverse stakeholders and agencies to discuss how to some of these ideas can be applicable to current challenges.