

Population Growth: Models, Projections, and Policies

- 1 GMA requirements
- 2 Population data and projections
- 3 Population models
- 4 Errors and invalid assumptions
- 5 Better models and projections
- 6 Policy suggestions and implications

http://www.ac.wvu.edu/~jmcl/Conservation/pop_proj.pdf

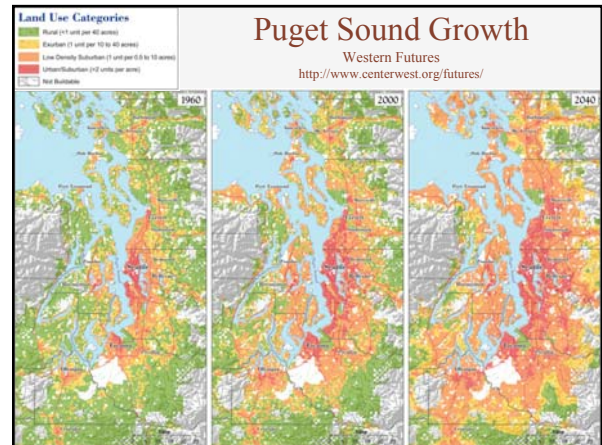
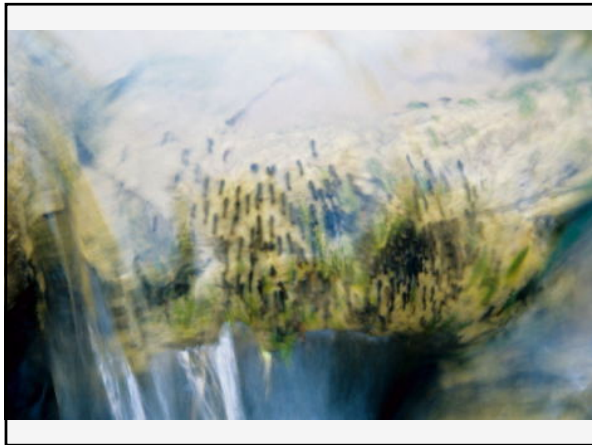
John McLaughlin
21 Nov. 2005

Environmental Context

“Human actions are depleting Earth’s natural capital, putting such strain on the environment that the ability of the planet’s ecosystems to sustain future generations can no longer be taken for granted.”

“The changes in policy and practice required are substantial and not currently under way.”

– Millennium Ecosystem Assessment (2005)



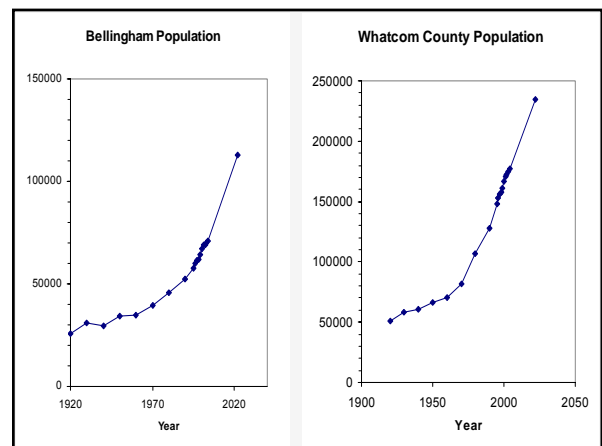
WA Growth Management Act RCW 43.62.035 Determining Population – Projections

OFM shall prepare 20-yr growth mgmt. planning pop. projections ...

The county and its cities may provide ... information ... relevant to [OFM's] projection, and [OFM] shall consider and comment on such information before adoption.

If any city or county believes that a projection will not accurately reflect actual population growth in a county, it may petition the office to revise the projection accordingly.

A comprehensive plan ... shall not be considered to be in noncompliance with the twenty-year growth management planning population projection if the projection used in the comprehensive plan is in compliance with the range later adopted under this section.



Adopted Growth Forecast

Year	Bellingham	Whatcom Co.
2002	81,454	173,471
2022	113,055	231,928
at same rate, would get:		
2042	156,920	310,080
2050	178,900	348,280
2062	217,790	414,580
2100	406,030	719,860

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ECONorthwest Population Model

$$N_{t+1} = c_1 N_t^{c_2} A^{c_3} E_t^{c_4} E_{t-1}^{c_5}$$

c_i = fitted constants

N_t = Population (year t)

A = Employment, average annual, Whatcom Co.

E_t = Number employed (year t)

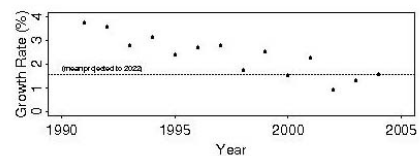
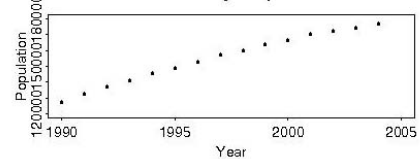
Errors in ECONorthwest Model

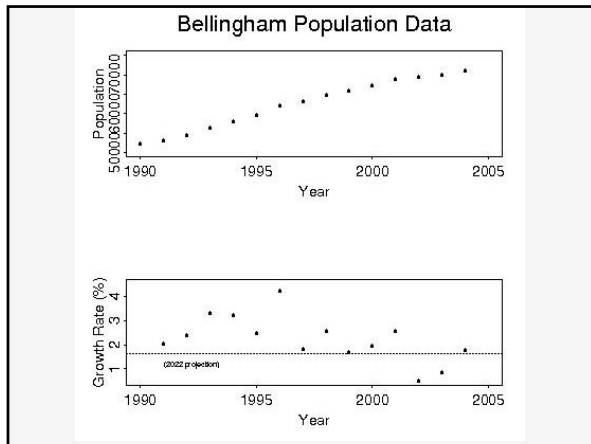
- 4 predictor variables;
 - 2 lack significant effect on population size
 - spurious results
- Collinearity among variables;
 - violates assumption of multiple regression
- Overfitted model; fits noise (i.e., connect dots)
 - perilous for projecting future
- Linear form to fit nonlinear relationships

Invalid Assumptions, ECONW Model

- Past trends will continue w/out change
 - population & employment growth rates
 - => no feedback
 - extrapolation beyond range of data
 - contradicted by data: declining growth rates
- Growth cannot be controlled
 - will continue at rapid rates of past no matter what we do
 - Reality: current subsidies encourage growth;
 - remove subsidies, and growth will slow

Whatcom County Population Data



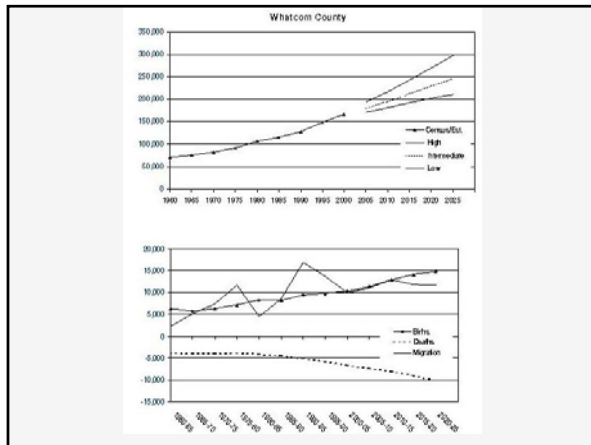


WA OFM Population Model

Pop. change = births – deaths + migration

$$N_{t+1} = \sum_{x=0}^k n_t(x)g(x) + \sum_{x=0}^k n_{f,t}(x)g(x)b(x) + \sum_{x=0}^k m_t(x)$$

N_t = total population
 $n_t(x)$ = number of age x at time t
 $g(x)$ = survival rate, age x to $x+1$
 $b(x)$ = fertility rate, age x
 $m_t(x)$ = net migration, age x at time t
 k = maximum age



Problems with OFM Model

- Fertility rates: assumed \uparrow slightly over 20 yr
- “Natural” increase is exponential
- Migration rates:
 - range: low–high decade migration for each county (1960 – 2000)
 - i.e., project past trends into future
 - does not consider real reasons for migration (employment opportunities, retirement, education)
- Same assumptions as ECONorthwest model
 - past trends continue
 - no control over growth

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Better models and projections

- Use valid analytical methods
- Include population feedbacks on:
 - endogenous growth
 - migration
- Represent economic factors realistically
- Include local policies

Logistic Population Model

- simple linear feedback
- carrying capacity (K)

$$N_{t+1} = N_t + rN_t \left(1 - \frac{N_t}{K}\right)$$

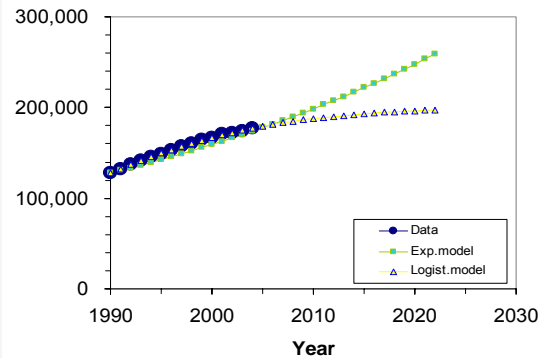
- variations: age structure
non-linear feedback
delayed feedback

Best model?

P(exponential) = 0.003%

P(logistic) = 99.997%

Whatcom County Population



Projected Population

2002 → 2022

	low	mid	high
OFM, Whatcom Co.	205,991	236,837	281,122
ECONw, Whatcom Co.	215,850	231,928	261,084
Logistic, Whatcom Co.	197,320		
Adopted, Whatcom Co.		234,917	
OFM, Bellingham	98,687	112,025	125,661
ECONw, Bellingham	104,228	109,818	117,472
Logistic, Bellingham	93,588		
Adopted, Bellingham		113,055	

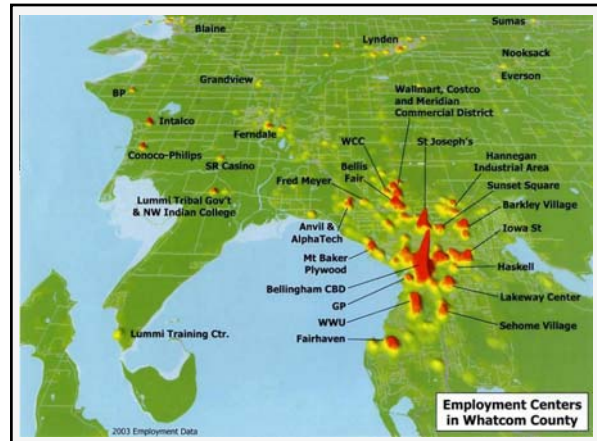
Projected Population Increase

2002 → 2022

	low	mid	high
OFM, Whatcom Co.	33,791	64,637	108,922
ECONw, Whatcom Co.	42,379	58,457	87,613
Logistic, Whatcom Co.	25,120		
Adopted, Whatcom Co.		61,447	
OFM, Bellingham	18,011	31,349	44,985
ECONw, Bellingham	22,774	28,364	36,018
Logistic, Bellingham	12,912		
Adopted, Bellingham		31,601	

Better Migration Forecasts

- Mechanistic economic models
- Kinds of jobs, housing possible/desirable
 - determinants of future jobs available
 - influences how many people will move here
- i.e., bottom-up economic model
(c.f., top-down by ECONorthwest, WA OFM)



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Policy Suggestions

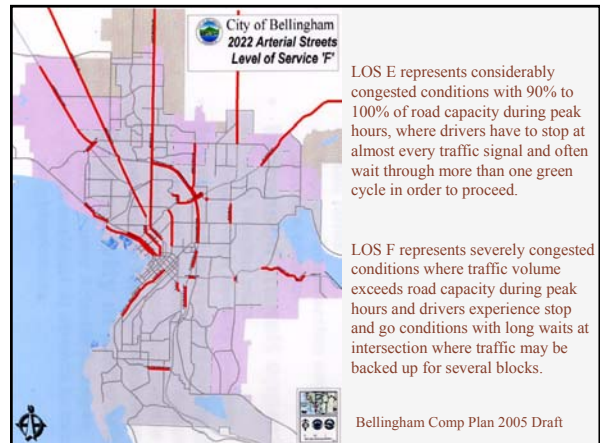
- Stop subsidizing growth
 - commercial relocation incentives
 - public financing of development infrastructure
- Retain & apply existing control mechanisms
 - transportation concurrency
 - environmental safeguards (CAO, SMA, SEPA)
- Require full-cost accounting for development
 - community impact analysis
 - require full-cost impact fees for new development
- Establish “ultimate” city boundaries
 - do not extend infrastructure, services
 - establish “greenbelt”
 - retain rural zoning

WA Growth Management Act

RCW 36.70A.070 Comp. plans – Mandatory elements

“...local jurisdictions must adopt and enforce ordinances which prohibit development approval if the development caused the level of service on a locally owned transportation facility to decline below the standards adopted in the transportation element of the comprehensive plan, unless transportation improvements or strategies to accommodate the impacts of development are made concurrent with the development.”

Bellingham: current peak LOS E for arterial streets.



Policy Implications

- Address need for affordable housing
- Real public influence on planning decisions
 - people experience growth impacts directly;
 - provide feedback needed for responsible planning
- Transition in building industry:
new development → redevelopment

Plan for Growth Limits

- Identify local/regional “carrying capacity”
 - space limits
 - density limits
 - traffic/transportation capacity
 - environmental limits
 - critical areas
 - stream impacts
 - greenway connectivity
- Include carrying capacity in pop. projections
- Include other feedbacks in pop. projections
- Plan within carrying capacity limits
- Reject applications that would exceed carrying capacity

Human Carrying Capacity

$$I = P * A * T$$

I: impact

P: population

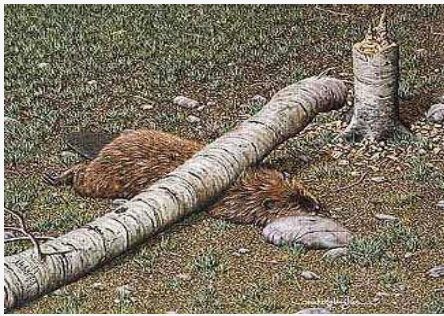
A: affluence (consumption)

T: technology

Conc: both population size and behavior count
where & how people live matters
to ↑P, must ↓consumption (e.g., walk vs. drive)

Calculating Human Footprint

- Global Footprint Network
<http://www.footprintnetwork.org>
- Individual footprint estimates
<http://ecofoot.org>
- City footprint analysis as planning tool
Cardiff, Wales:
[http://www.cardiff.gov.uk/SPNR/Strategic_Planning/...
...New_Strategic_Planning/Sustainability/footprint.htm](http://www.cardiff.gov.uk/SPNR/Strategic_Planning/...New_Strategic_Planning/Sustainability/footprint.htm)



Plan ahead ... ignorance is not bliss.