Comparison of Fish Habitat in Portland Streams

A Project by Sheila Davis and
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Geog 590 PSU Winter 09

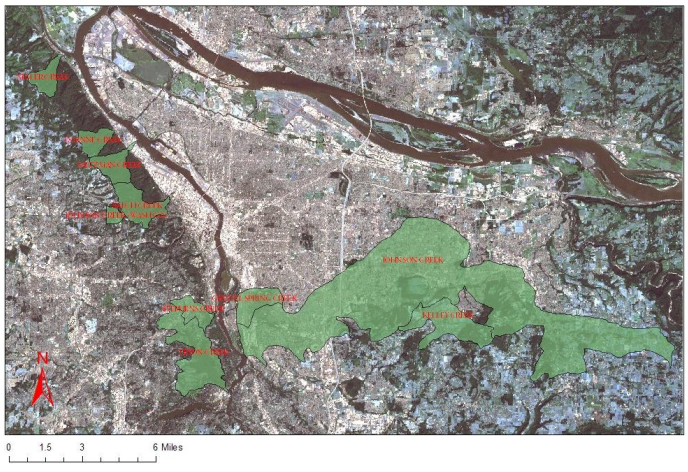
Project Inspiration

- "Abundance and Distribution of Fish in City of Portland Streams."
- Oregon Department of Fish and Wildlife, 2003
- Authors:
  - Tinus, Eric.
  - Koloszar, James.
  - Ward, David.

ODFW Study Overview

- Purpose
  - Determine distribution and habitat of fish use
    - Partnered with City of Portland for ESA Program
  - Assist in setting priorities for management
- Goals
  - Identify fish species assemblages and distribution
  - Identify seasonal changes in distribution
  - Calculate Index of Biotic Integrity (IBI)
  - Estimate salmonid abundance
  - Evaluate population dynamics of listed species

ODFW Study Area



ODFW Study Methods

- Fish Surveys
  - Backpack Electrofisher
  - Presence/Absence Surveys
    - Summer 2001 and 2002
  - Multi-Pass Removal (MPR) Surveys
    - Block netting 100m reaches
    - Maximum of 3 passes
    - Seasonally from Summer 2001 to Spring 2003
- Data Analysis
  - IBI calculations based on fish collected and identified
    - Non-Salmonids collected only in first pass
  - Population Estimates of Salmonids
    - Based on MPR catch data
  - Population Dynamics
    - Fork Length Ranges
      - Proportions of Age Classes by Species
      - Proportions of Age Classes by Location

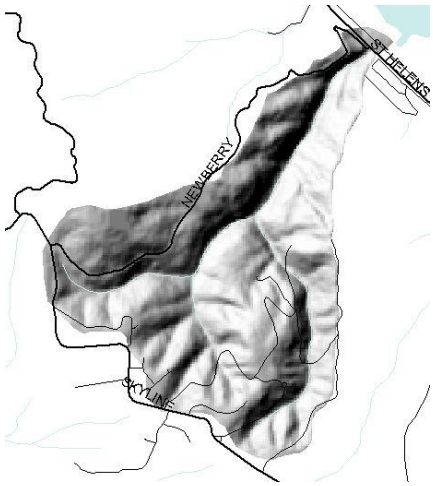
Our GIS Project Goals

- Use GIS tools to analyze geographic data related to streams in study
- Determine what role geographic features may play in fish population data within report
- Focus on Miller Creek and Tryon Creek to analyze two watersheds with distinctly different features
- Potential models for predicting
  - Fish presence
  - Health?
- Identify problems in modeling
- Identify areas for development or improvement

Focus Areas:

Miller Creek
(Willamette Watershed)
&
Tryon Creek
(Tryon Creek Watershed)

Miller Creek



Historic Miller Creek

- First Order Stream
- Narrow floodplain
- High connectivity to Willamette
- Approximately 2.4 km in length
- Moderately steep, confined channel
- Perennial and spring fed
  - Dry channel in middle and upper sections
- No natural barriers
- Good habitat for salmonids
  - Large wood
  - Spawning and rearing habitats
  - Off-channel and in-channel refugia
- Fish species composition unknown

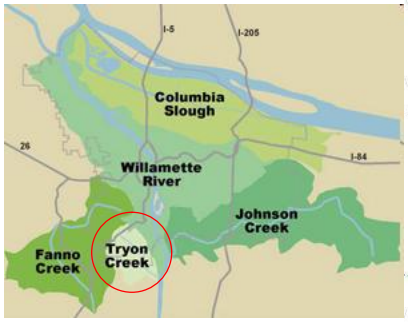
Current Miller Creek

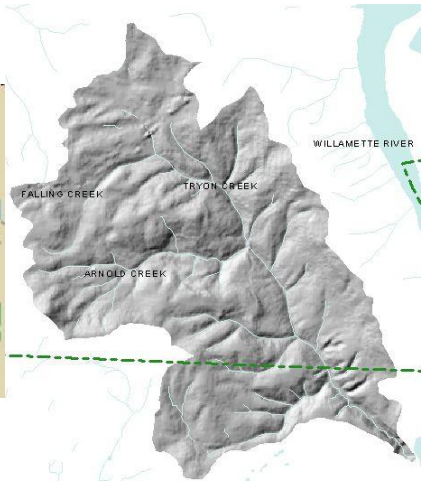
- Mouth of creek moved in 1990
  - Floodplain extensively modified (industrial use)
- Short distances of creek piped and rerouted
  - Double box culvert under railroad and Marina Way
    - Baffles increase adult passage in winter
    - Baffles hinder juvenile movement during summer
- Substrate
  - 60% cobble, 35% gravel and 5% boulders (CoP, 1990)
  - High amount of silt and organics & cobble and gravel (ODFW, 2003)
- Erosion
  - High in upper reach – 72%
  - High in middle reach – 56%
  - Moderately High in lower reach – 47%

Current Miller Creek (cont.)

- Dominant habitat types
  - Upper Reach: Cascades (64%) and dry channel (34%)
  - Middle Reach: Cascades (57%) and riffles (14%)
  - Lower Reach: Pools (45%) and riffles (29%)
- Flow
  - Ranges from < 0.1 cfs in summer to 1.2 cfs in winter

Tryon Creek





Historic Tryon Creek

- One of the largest urban watersheds in Oregon
- Contains 3 subwatersheds
  - Tryon Creek Mainstem: First Order Stream
  - Falling Creek
  - Arnold Creek
- Tryon Creek State Park
  - Land acquisition in 1971-1972
    - 600+ acres
  - Park dedicated in 1975
- Fish Species
  - Coho, Chinook, Steelhead, Cutthroat Trout, Pacific Lamprey

Current Tryon Creek

- Dominant land use
  - Single family residential
  - Natural Area (Tryon Creek State Park)
- Sediment
  - Sandy loam
  - Siltation caused by large amounts of runoff and low infiltration from impervious surfaces
- Culvert
  - ~122 m long, 6.7 m vertically (5.4% grade)
- Flow
  - Ranges from 0.5 cfs to 50 cfs
    - Based on monthly mean from 2002 - 2007 (USGS)

Watershed Area Features

Geographical Data Sources

Land Imperviousness data, 30m raster

Multi Resolution Land Characteristics Consortium, part of NLCD 2001 data.

Portland Area RLIS data; Metro

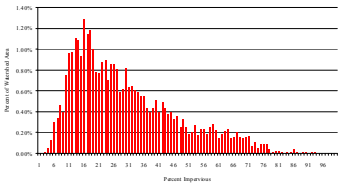
10m DEM, streams, roads, watersheds.

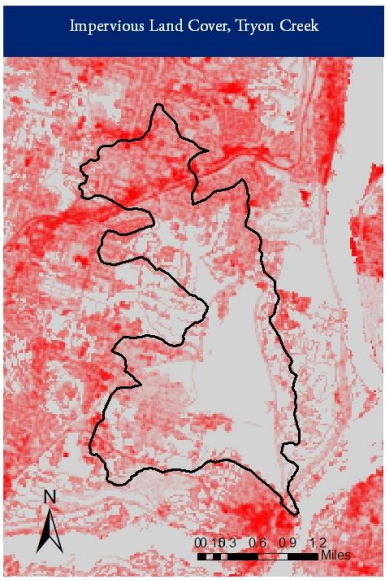
Satellite Imagery of Portland Area; PSU

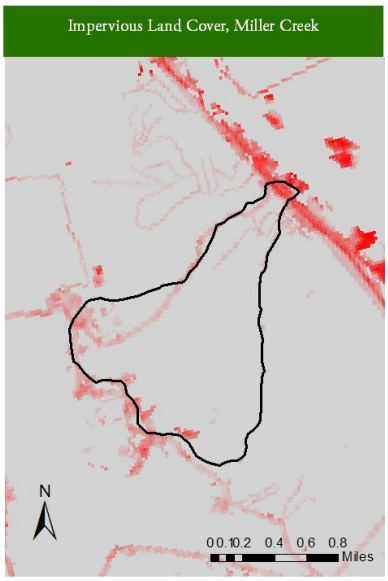
used to generate unsupervised land use classification.

Imperviousness..

Kelley Creek

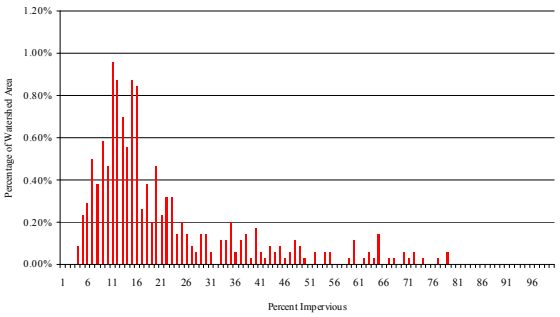




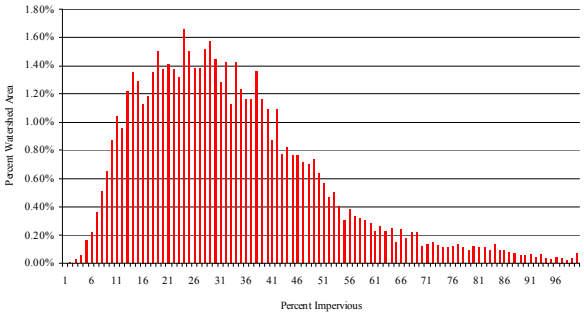


*Red indicates varying presence of impervious surfaces

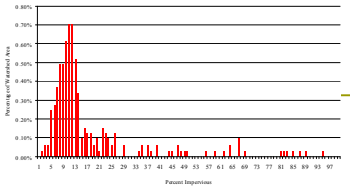
Miller Creek



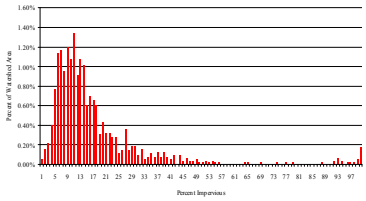
Tryon Creek



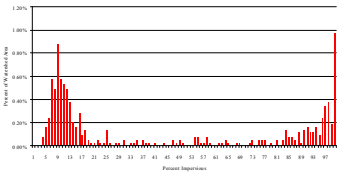
Doanne Creek



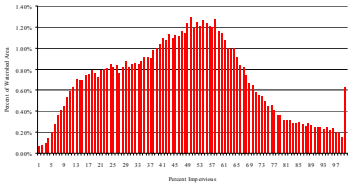
Balch Creek



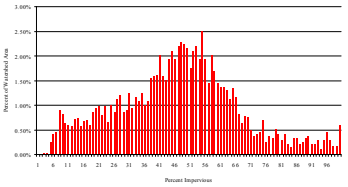
Saltzman Creek



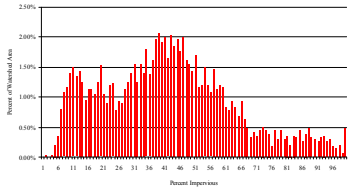
Johnson Creek



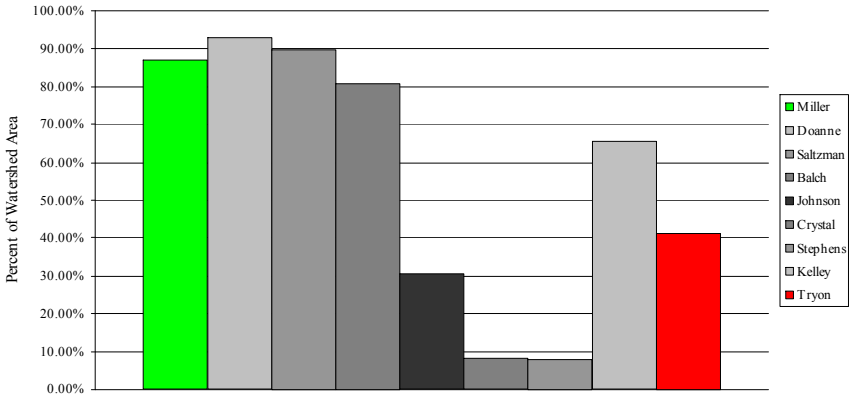
Crystal Creek



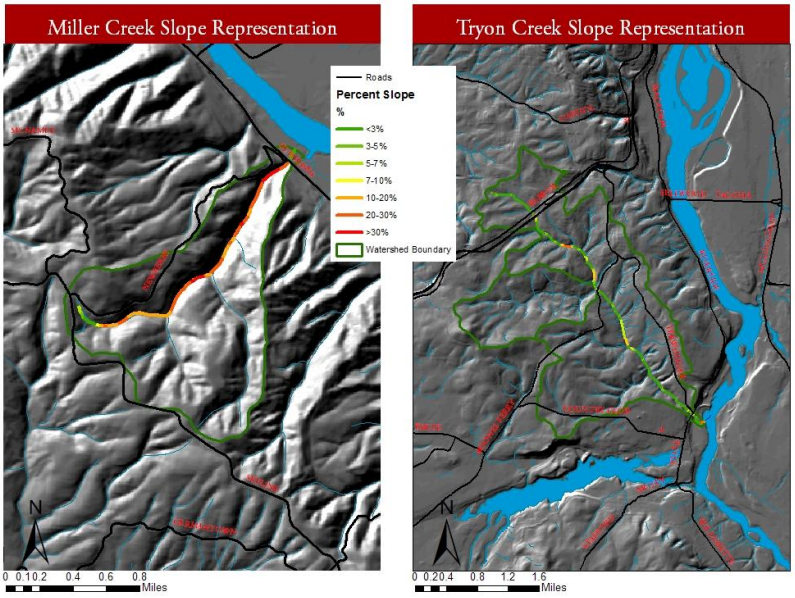
Stephens Creek



All Creeks: *Area 0% Impervious*

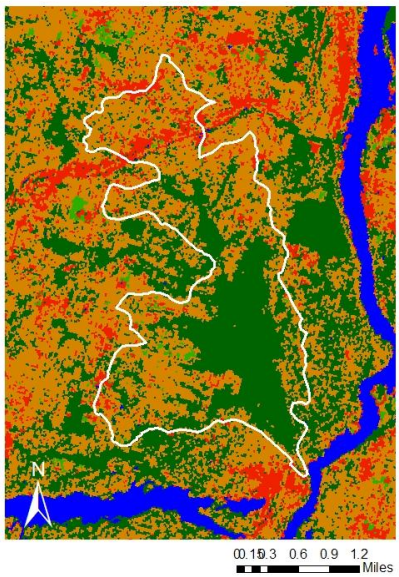


Slope

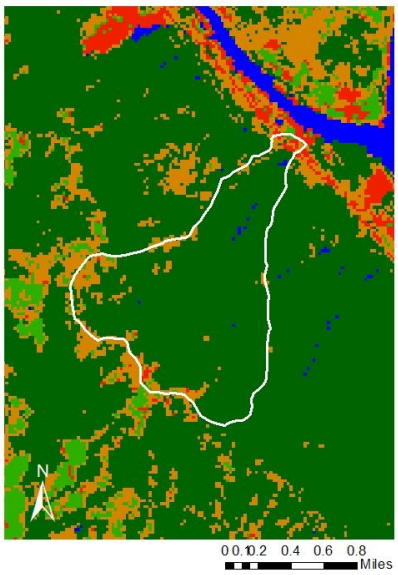

Miller Creek Slope Representation
Tryon Creek Slope Representation
Roads
Percent Slope
%
<3%
3-5%
5-7%
7-10%
10-20%
20-30%
>30%
Watershed Boundary
N
0 0.1 0.2 0.4 0.6 0.8
Miles
N
0 0.2 0.4 0.8 1.2 1.6
Miles

Land Use

Land Use, Tryon Creek



Land Use, Miller Creek

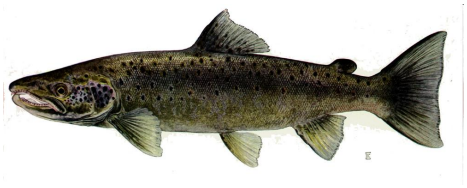


Legend: Red = Urban/Industrial/Transportation; Orange = Residential;
Light Green = Agriculture; Green = Environmental; Blue = Water

Land Use Area

	percentage of total watershed
Miller Creek	
water	0.38%
environmental	88.89%
residential	8.80%
urban/industrial/transportation	1.11%
agriculture	0.82%
Tryon Creek	
water	0.10%
environmental	44.85%
residential	47.53%
urban/industrial/transportation	6.34%
agriculture	1.17%

Fish Data



Index of distribution and abundance (estimated number of salmonids per linear meter of stream) of salmon and trout by location and season in City of Portland streams.

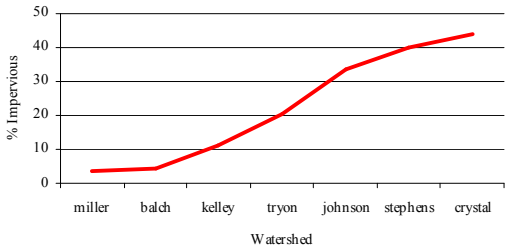
		Season				
Stream	***Reach***	***Summer***	***Fall***	***Winter***	***Spring***	***Mean***
Tryon	3	--	0.41	0.21	0.04	0.22
Tryon	4	0.12	0.18	0.14	0.22	0.165
Tryon	1	0.34	0	0.07	0.23	0.16
Miller	1	0.2	0.08	0.15	0.114	0.136
Tryon	2	0.07	0.04	0.06	0.13	0.075

- Indices for each stream reach are ordered from highest to lowest average density.
- Population estimates with extreme confidence interval bounds are not included.
- Reached where values are less than 0.001 and salmonids have not been observed are assigned a value of 0.

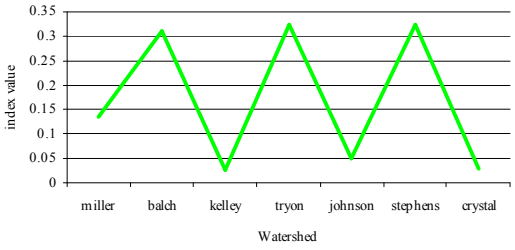
The eternal search for correlation…

- Used mean index of distribution and abundance data
- Compared to geographic data:
  - Reclassed and calculated average ground imperviousness for each watershed from ODFW study
  - Land Use area percentages per watershed.
  - Percentage of slope per stream reach.

Avg. Imperviousness By Watershed



Avg. Index of Distrib. & Abundance (All Seasons)

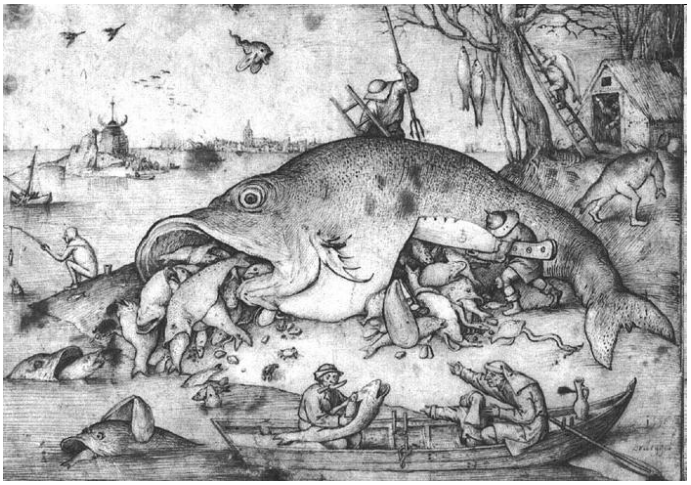


*Slope and Land Use data demonstrated equally low correlation to average fish catch data, therefore graphs were not included.

Statistics means never having to say you're certain.

- Data shows little correlation between geographical factors vs. fish catch data
- Additional factors severely impact fish presence, fish catch data
- Measures of human development and impacts?
- Additional factors: pollution, flow, turbidity, substrate content, obstructions, etc.

IBI and Population Modeling….



Index of Biotic Integrity (IBI)

- From ODFW report:
  - An IBI is a scoring criteria used to assess the ecological condition of a stream as it relates to fish assemblage conditions (Reynolds et al. 2003). The IBI is useful for assessing the effects of humans on entire fish assemblages.
  - IBI scores are based on a possible maximum score of 100. Streams with an IBI <50 are considered severely impaired, streams scoring 51-74 are marginally impaired, and streams with a score >75 are considered acceptable.

IBI Data

		2001			2002					2003	
Stream	***Reach***	***P/A***	***S***	***F***	***W***	***Sp***	***P/A***	***S***	***F***	***W***	***Sp***
Tryon	1	54	71	74	N/S	54	40	65	25	56	66
Tryon	4	42	51	51	N/S	51	48	51	65	51	65
Miller	1	44	35	34	41	68	68	51	49	58	64
Tryon	2	41	41	46	N/S	41	38	41	41	50	50
Tryon	3	50	32	41	N/S	41	46	41	39	40	43
Miller	2	N/A	34	38	34	51	48	N/A	34	34	34

Index of Biotic Integrity (IBI) scores by stream reach and season for Portland area streams, summer 2001 - spring 2003. Presence/Absence surveys done in summer. All others are multiple-pass removal surveys. Stream reaches are ordered from highest to lowest mean IBI score. N/S = Not surveyed, N/A = Not applicable.

Modeling

- Ideally
  - Develop model to assess fish population habitat
  - Use relationships between population data and geographic factors
- Human Impact
  - Difficult to quantify
  - Myriad of factors result in complex models
- Culverts pose a problem
  - No/low potential for upstream migration of salmonids
  - Few resources (none?) regarding population models involving culverts

Impacts of Culverts

- Tryon Creek Fish Species
  - Above Culvert: Steelhead (Rainbow Trout), Coastal Cutthroat Trout
  - Below Culvert: Steelhead, Coastal Cutthroat Trout, Coho, Chinook
- Tryon Creek Culvert
  - Baffles create structure; Lack holding areas within culvert
  - Culvert entrance above base level flow height (~8 inches)
- Miller Creek Fish Species
  - Above Culvert: Coastal Cutthroat Trout
  - Below Culvert: Steelhead, Coastal Cutthroat Trout, Coho, Chinook

Human Development

- Miller Creek
  - "**Partial or complete barriers to fish passage** are **present in Miller**, Doane, Saltzman, and Stephens creeks. Even though reach 2 of Miller Creek is small, it has excellent habitat in terms of canopy cover, diversity of habitat units and substrates, variety of native vegetation, absence of invasive plants, and presence of large woody debris. **If it were accessible, Miller Creek might support small populations of cutthroat trout, steelhead, and coho salmon**."
- Tryon Creek
  - "Fish passage is provided between reaches 1 and 2 of Tryon Creek, but the **culvert may not function properly under certain conditions**. The old metal baffles trap wood that obstructs flow between baffles. When plugged with woody debris, the **water is too shallow during low flows and may be a velocity barrier at high flows**. The **height between the plunge pool surface and the culvert outflow may be too great** for small fish to swim upstream."

Habitat Health Modeling

- EPA developed models (Rashleigh et al., 2008)
  - CADDIS
    - Stressor Identification
  - BASS
    - Simulates Population Dynamics, Bioaccumulation Dynamics and Non-Chemical Stressors (Thermal, Non-Native Species, Sport Fishing, etc.)
  - AQUATOX
    - Predicts fate of Pollutants and Effects on Ecosystems
- Beyond the scope of this project

Recommendations

- Install "Fish Friendly" culverts

References

- Rashleigh, B., M. C. Barber, S. Cormier. 2008. EPA's Ecological Models for Integrated Watershed Management. Water Environment Federation Report.
- Reynolds, L., A. T. Herlihy, P. R. Kaufmann, S. V. Gregory, and R. M. Hughes. 2003. Electrofishing effort requirements for assessing species richness and biotic integrity in western Oregon streams. North American Jounal of Fisheries Management 23:450-46.
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- Friends of Tryon Creek. http://www.tryonfriends.org, Feb. 2009.