Appraisal Level Economic Analysis for the ESPA Comprehensive Aquifer Management Plan
Demand Reduction Options

Date: August 28, 2008

waterexchange.com

Introduction

Purpose: **Describe the potential range of costs associated with water purchases within the East Snake Plain to develop a comparison to other management alternatives and identify the potential funding requirements for implementation.**

General Approach: Land Price Differential Analysis

- Land and water are commonly sold as a bundled commodity in the ESPA. The statistical approach reveals the implicit price of water by comparing the sale price of property with and without irrigation.

Presentation Outline:

- **Brief Literature Review**
- **Data Summary**
- **Methodology**
- **Model Results**
- **Application of the Model**
- **Other Demand Reduction Options**

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Literature Review

Land Price Differential (hedonic) models have been previously applied to estimate the value of irrigation water values at a regional level. The approach is particularly relevant in regions with a limited history of water right sales separate from other real property.

- Crouter (1987) used hedonic models to determine if the water rights market in Weld County, Colorado, was separate and competitive from the land market. Crouter found that the value of land and water rights could not be estimated separately and thus the water rights market was not separate and competitive. As result, the hedonic model proved to be a preferred method to measure water right prices.
- Faux and Perry (1999) estimated water values in Malheur County, Oregon. The model found soil type, value of buildings and proximity of land to major cities as significant factors in land prices.
- Veeman et al. (2001) used a hedonic model to estimate the price of water in southern Alberta. The study showed that irrigation, buildings, land area, and distance to major cities significantly affected farm land prices.

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Data Summary

- WestWater obtained agricultural land sales data for 411 transactions within the ESPA from 2003 through June 2008.
- The sales data included total sale price, estimated value of improvements, primary land use, primary commodity, acres irrigated, and location, among other values.
- 73 sales were dropped from the analysis because the sales were for land primarily used for commercial or residential purposes.
- Included sales larger than 20 acres to limit the sales to agricultural properties. This acreage limitation removed an additional five sales from the data set.
- Applied GIS analysis to develop and test additional characteristics that can affect land and water values such as distance to town, elevation, located within an irrigation district, proximity to dairies, groundwater depth, etc.

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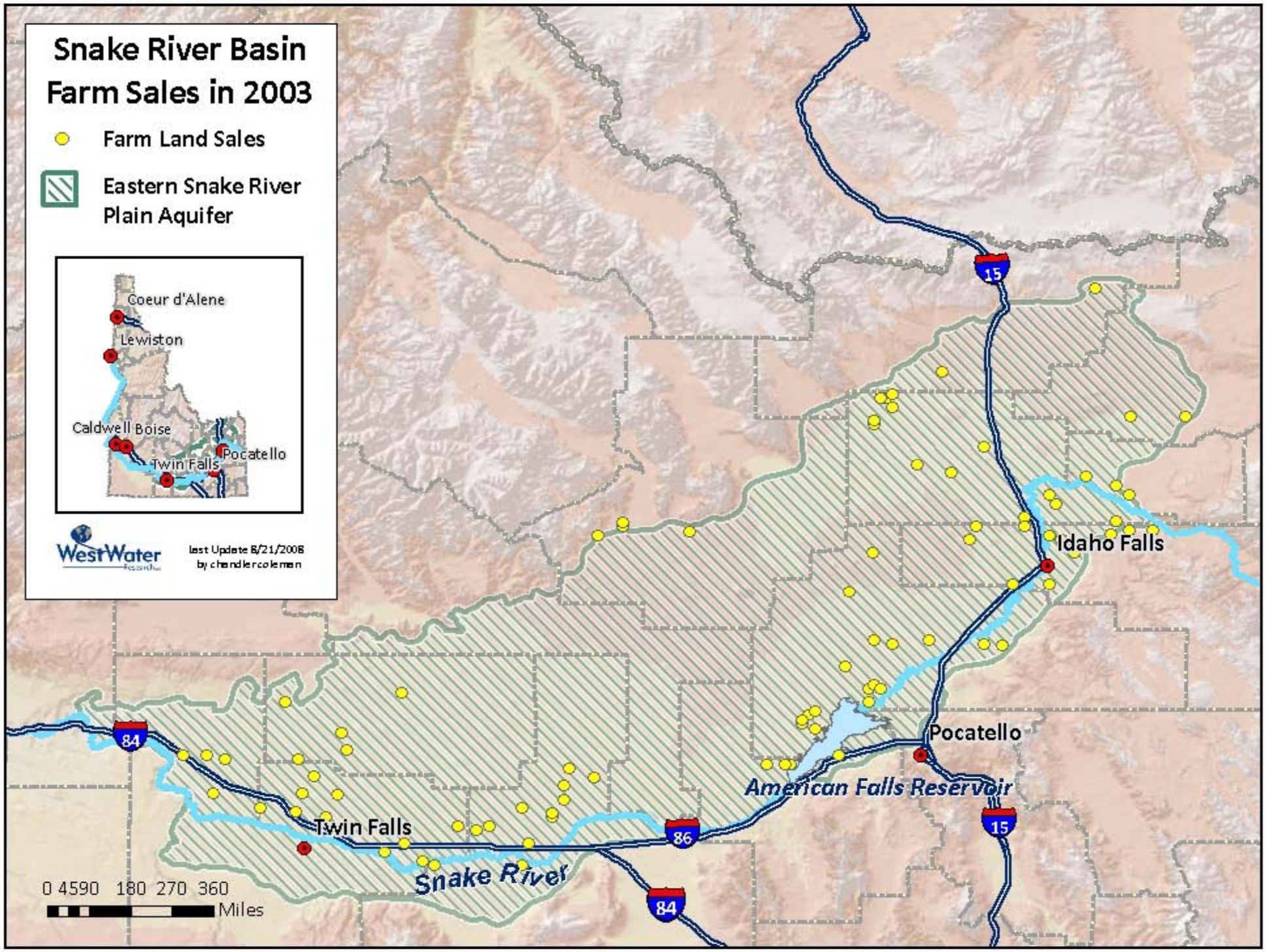
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Farm Sales in 2003
Farm Land Sales
Eastern Snake River
Plain Aquifer
Coeur d'Alene
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Caldwell
Boise
Twin Falls
Pocatello
WestWater
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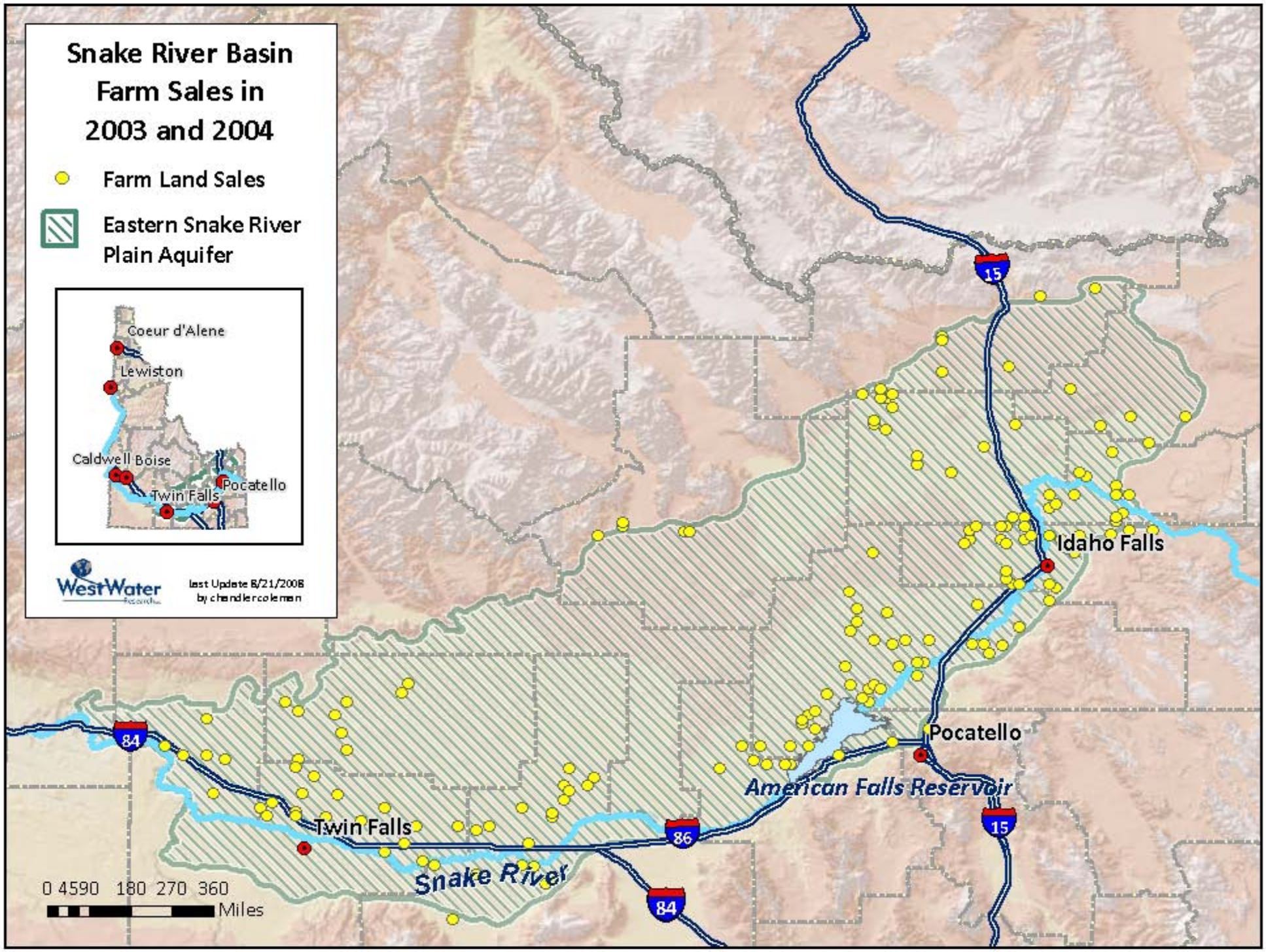
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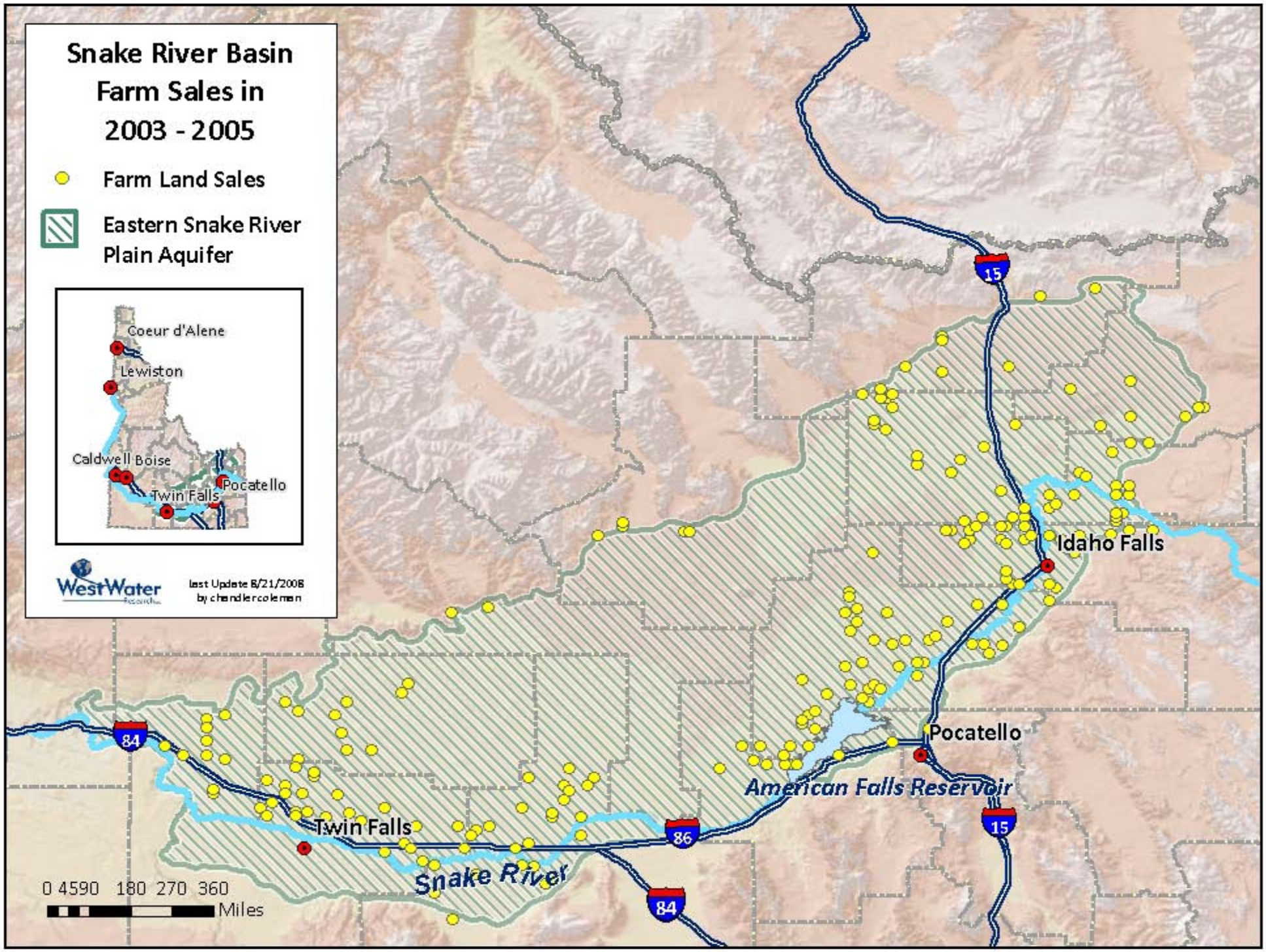
Snake River Basin
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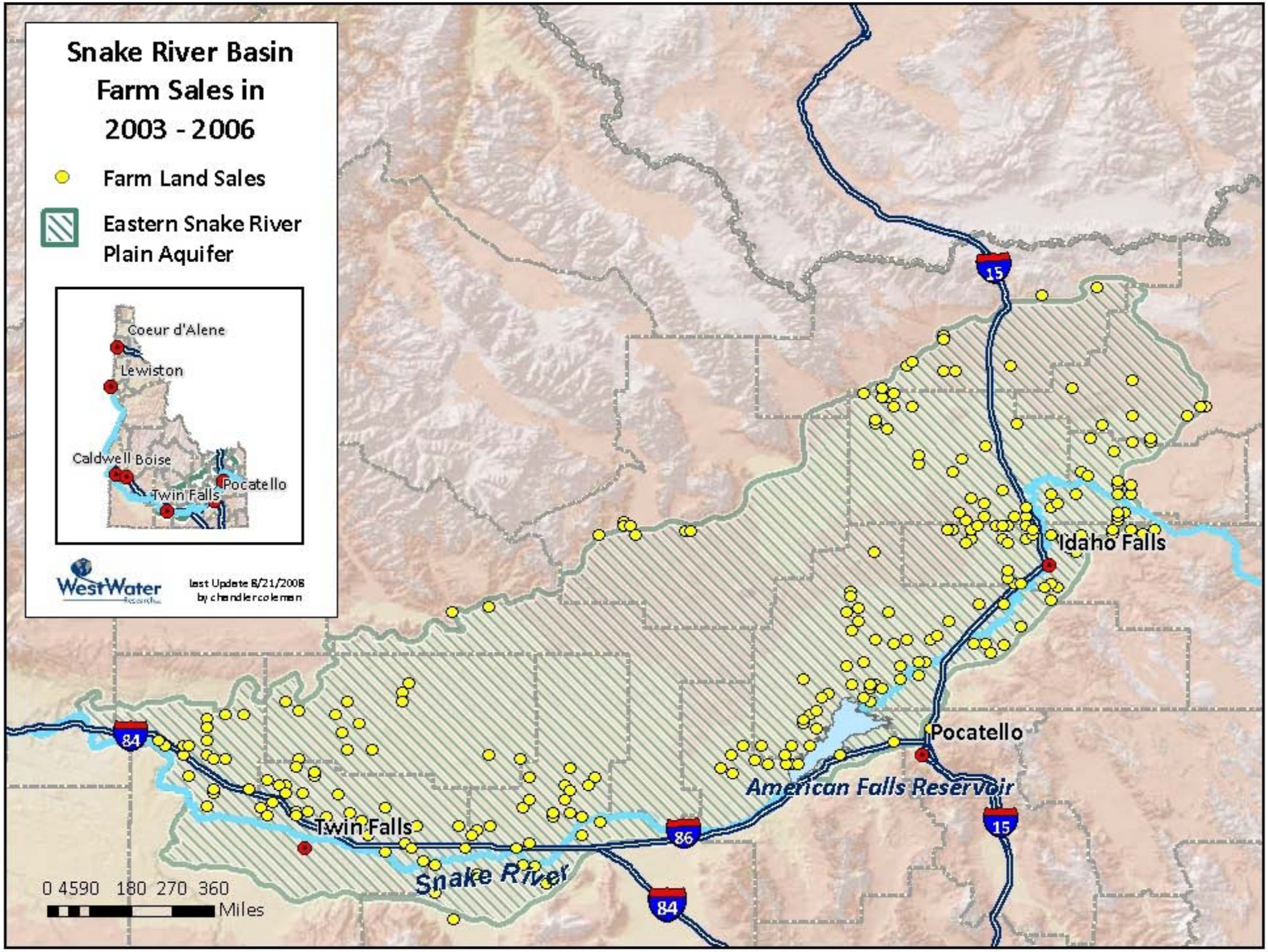
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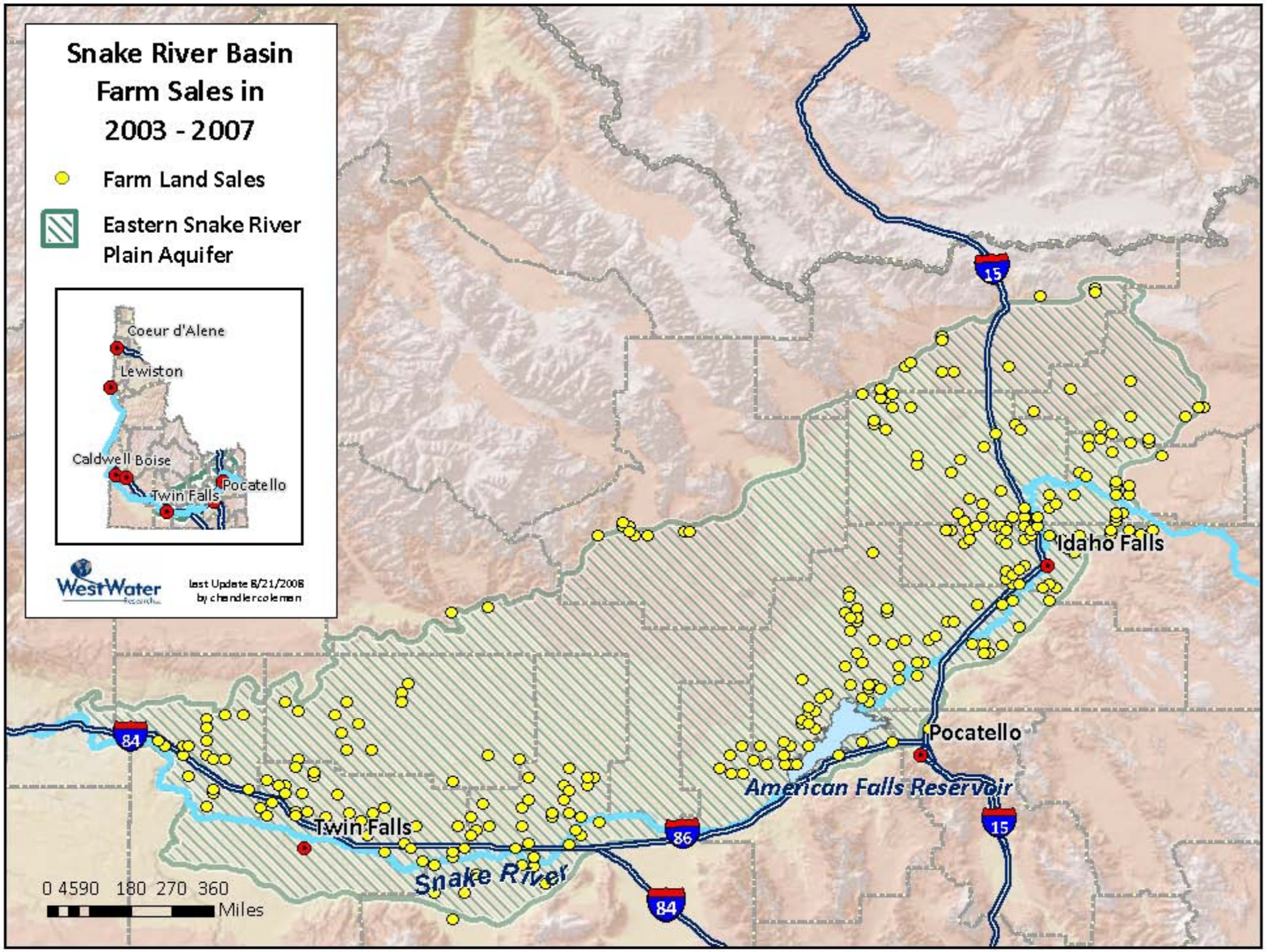
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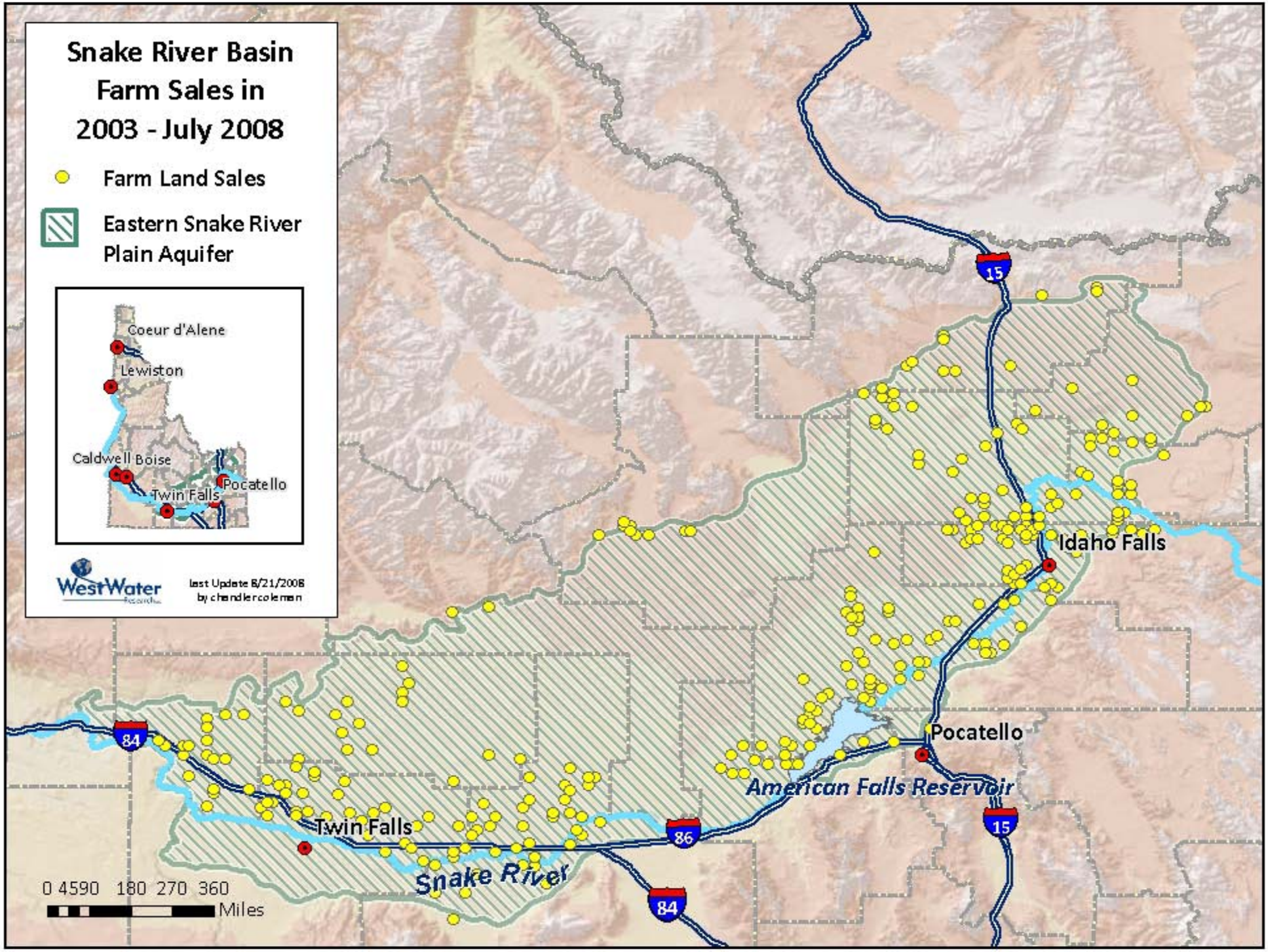
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Farm Sales in
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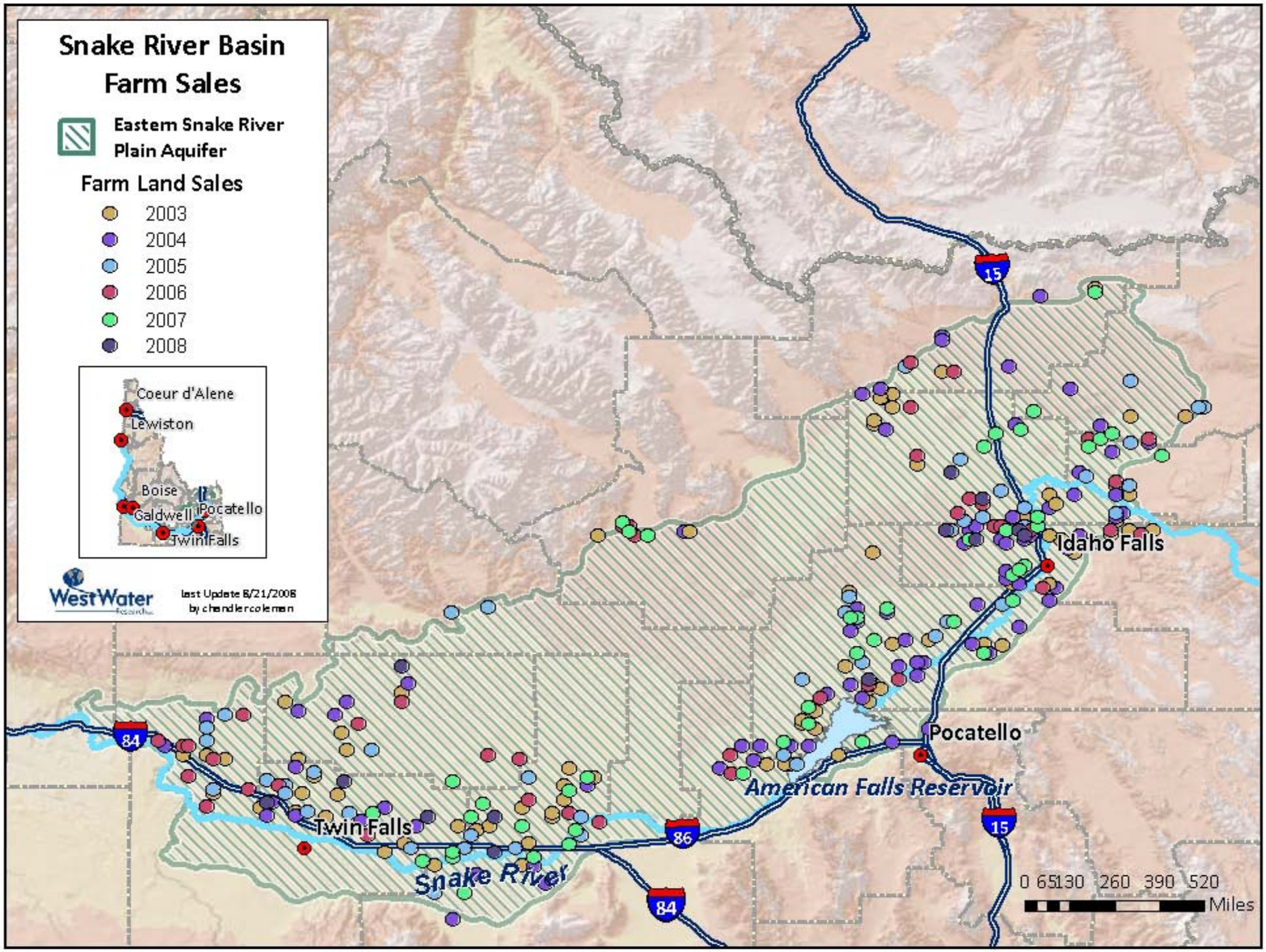
Snake River Basin
Farm Sales
Eastern Snake River
Plain Aquifer
Farm Land Sales
2003
2004
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Lewiston
Boise
Caldwell
Pocatello
Twin Falls
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Miles

Data Summary

- The average price for property in the Basin was $2,794 per acre but ranged significantly from $125 to $13,567 per acre (including the value of improvements).
  - The price varies according to improvement values, land size, percent of land irrigated, and distance to town.
- The "average" farm had:
  - an estimated improvement value of $365 per acre;
  - 611 acres;
  - 82% of its land irrigated;
  - a distance of 23 miles from a town with more than 10,000 residents.

Agricultural Land Sales Summary

	Obs	Mean	Std. Dev.	Min	Max
Price ($/acre)	333	$2,794	$1,674	$125	$13,567
Estimated Value of Buildings ($/acre)	333	$365	$693	$0	$4,335
Farm Size (acres)	333	611	1,094	22	12,000
Percent of Land Irrigated	333	82%	23%	0%	100%
Year	333	2004	1.6	2003	2008
Distance to Town (miles)	333	23	14	3	64

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Methodology

- Dependent Variable – Price per Acre
- Explanatory Variables Tested:

Variable	Expected Sign	Notes	Outcome
Irrigated Acres/Total Acres	+	Value increases with irrigation	Included in Model
Value of Improvements per Acre	+	Obtained from appraiser estimate	Included in Model
Total Sale Acres	-	Per acre price declines with larger sales	Included in Model
Year of Sale	+	Agricultural land values have generally been increasing	Included in Model
Location in ESPA	+/-	No prior expectations on sign	Included in Model
Distance from Towns (>10,000)	-	Land further from population centers generally has a lower price per acre	Included in Model
Primary Crop Type	+/-	Potato/sugarbeet grounds sells at a premium?	Not Included in Model
Pumping Lift	-	Higher groundwater lifts depress land price	Included in Model
Land Class	+	Higher quality land sells at a premium	Not Included in Model
Priority Date	+	More senior water rights sell at a premium	Not Included in Model
Proximity to Dairies	+	Land near dairies sells at a premium	Not Included in Model

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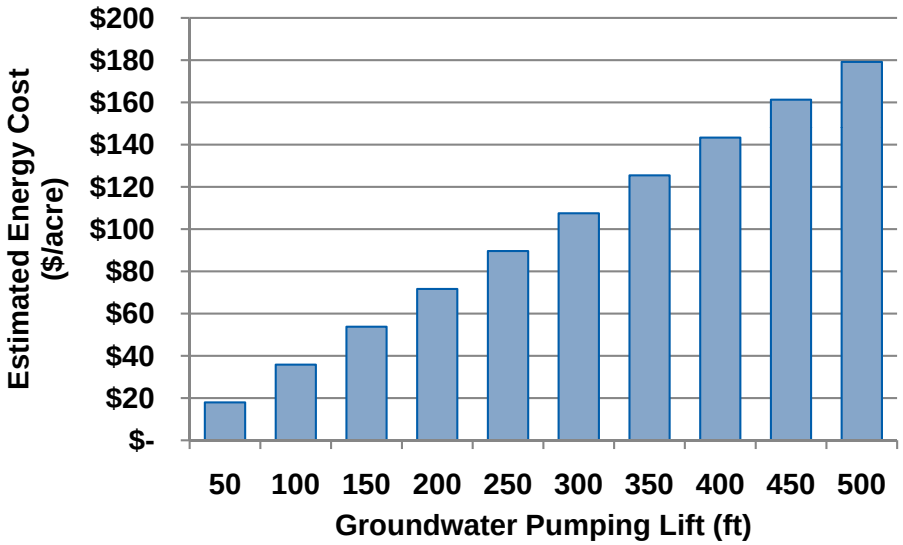
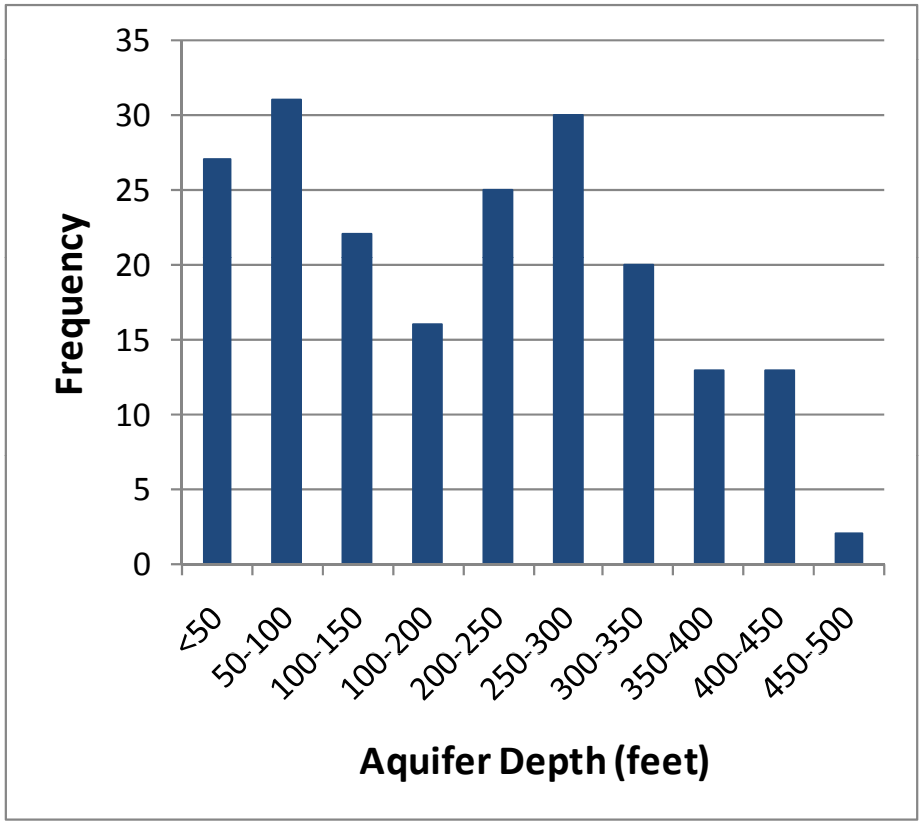
Methodology

- **Water Source:** Farms with higher pumping lifts are expected to have lower irrigated land prices than farms with shallower groundwater sources or farms that utilize surface water. Estimated pumping lift varied among the land sales.



Sale Frequency by Aquifer Depth for Farms that Use Groundwater



Sources: Mean Depth to Aquifer comes from the Idaho Department of Water Resources, July 18, 2008. Water source represents water sources estimated in 2000 from Idaho Water Resources Research Institute, received January 2008.

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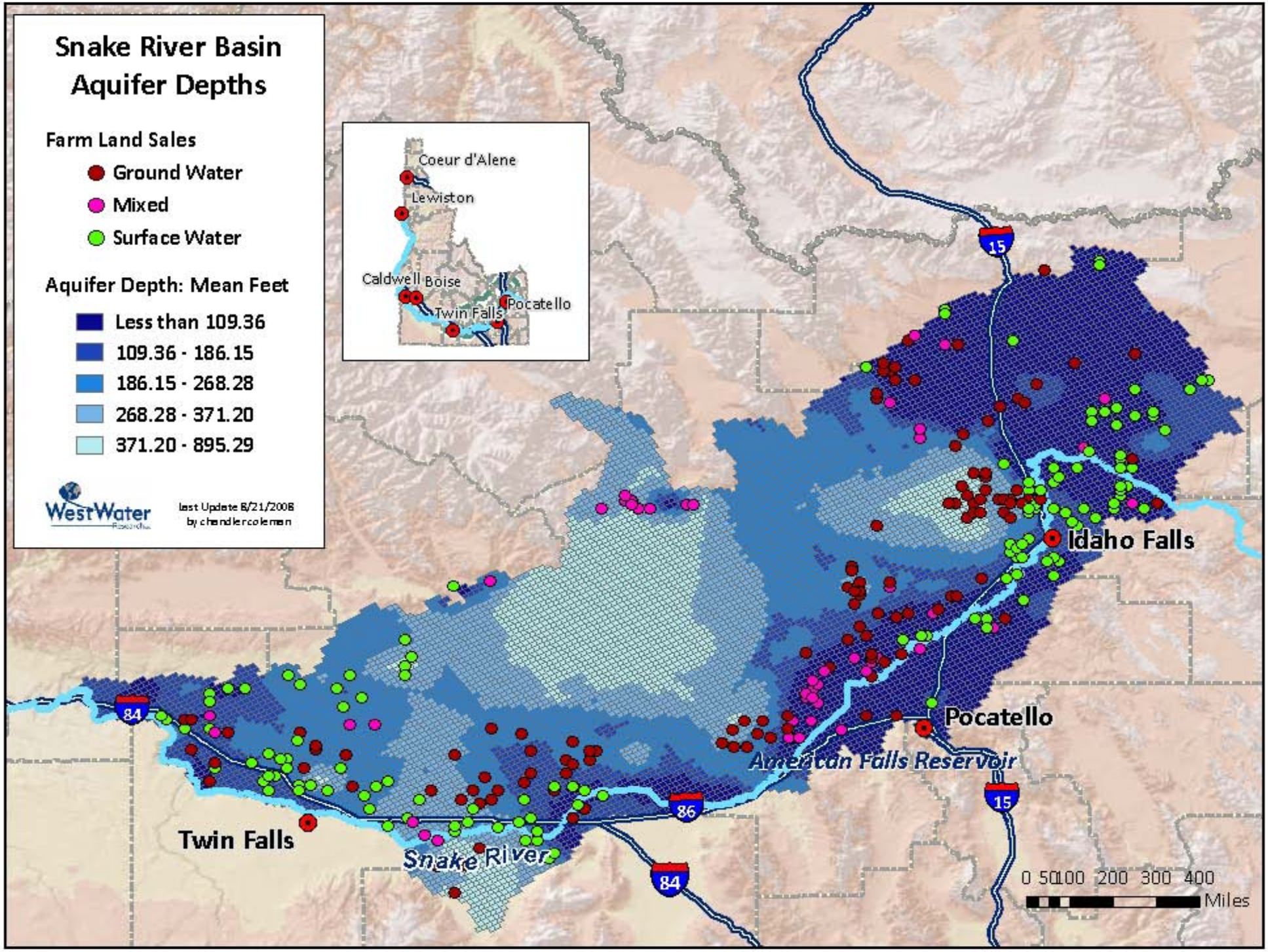
Snake River Basin
Aquifer Depths
Farm Land Sales
Ground Water
Mixed
Surface Water
Aquifer Depth: Mean Feet
Less than 109.36
109.36 - 186.15
186.15 - 268.28
268.28 - 371.20
371.20 - 895.29
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Methodology

Price per Acre Summary Statistics by Percent of Land Irrigated

	Obs	Mean	Std. Dev.	Min	Max
WATER <25%	16	$1,221	$1,424	$125	$4,426
WATER 25%-50%	16	$2,076	$1,738	$351	$5,922
WATER 50-75%	40	$2,125	$1,538	$352	$7,837
WATER 75%-100%	261	$3,037	$1,618	$498	$13,567
ALL Observations	333	$2,794	$1,674	$125	$13,567

- The primary variable of interest is the percent of acres irrigated.
- Farms with a higher percentage of irrigated land have a higher sale price per acre.
  - Farms with 75 percent or more acres irrigated on average sold for $912 per acre more than farms with 50-75 percent of the land irrigated.
  - Moreover, properties without irrigated land sold on average for nearly $2,000 less per acre than those lands with at least some irrigation.

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Economic Model Results

- The selected economic model is:

  $PRICE=\beta_0+\beta_1 IMP+\beta_2 WATER_Z1+\beta_3 WATER_Z2+\beta_4 WATER_Z3+\beta_5 WATER_Z4+\beta_6 WATER_Z5-\beta_7 LACRES+\beta_8 Y-\beta_9 LDTOWN-\beta_{10} GWDEPTH+e$

  Where the *βs are the regression coefficients and e is the error term*
- The economic model explains 74% of the variation in PRICE, according to the R-squared.
- The variables are significant at the 10% confidence level or higher.

Empirical Results

Variable	Description	Coef.	Std. Err.	t
IMP	Estimated Improved Value/Acre	1.4	0.133	10.73
WATER_Z1	Percent of Acres Irrigated Zone 1	1,788.3	281.630	6.35
WATER_Z2	Percent of Acres Irrigated Zone 2	2,047.2	279.332	7.33
WATER_Z3	Percent of Acres Irrigated Zone 3	2,239.5	308.429	7.26
WATER_Z4	Percent of Acres Irrigated Zone 4	1,259.8	251.841	5.00
WATER_Z5	Percent of Acres Irrigated Zone 5	1,317.6	287.399	4.58
LACRES	Log of Acres	-91.2	54.936	-1.66
Y	Year Index (2003=1,2004=2…)	186.9	32.417	5.76
LDTOWN	Log of Distance to Town	-934.7	114.186	-8.19
GWDEPTH	Depth to Aquifer for Farms that use Groundwater (feet)	-1.7	0.378	-4.50
_cons	Constant	3,891.5	516.620	7.53

R-squared= 73.56
N=333

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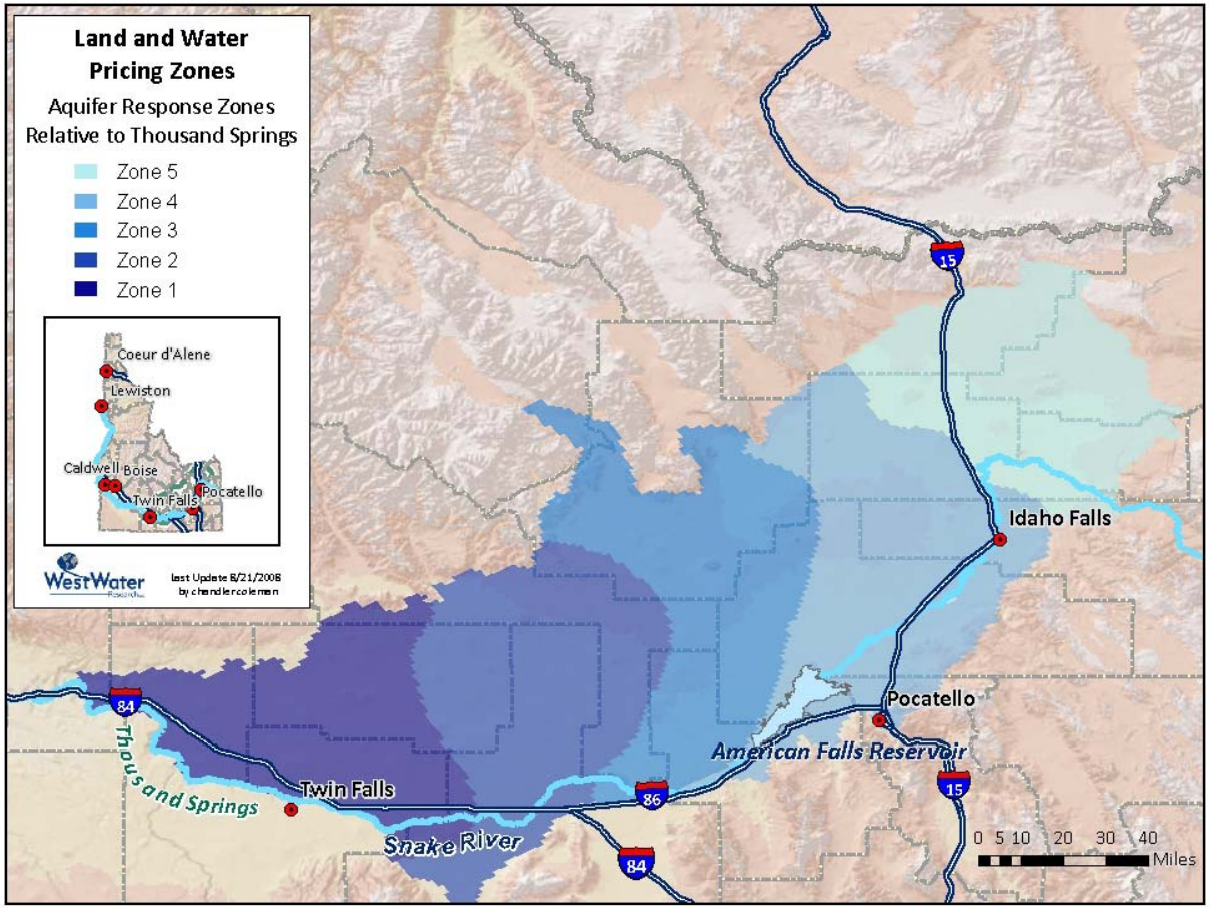
Economic Model Results

- The Economic Model Zones are based on the reach gains to the Thousands Springs reach and measured using the ESPA aquifer model run in long-run equilibrium model.
- The reach gains were calculated throughout the ESPA, then grouped into five zones based on quintiles.
  - Zone 1 has the greatest reach gain to the Thousands Springs reach. Zone 5 has the lowest reach gain.



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Economic Model Results

Other Tested Variables

Variable	Definition	Results
POTAT (binary)	Primary crop potato	Not significant
HVCROPS (binary)	Primary crop Potatoes, cash crops,	Not significant
CATTLE	Primarily produce dairy or livestock	Not significant
DSNAKE (miles)	Distance to the Snake River	Correlated with DTOWN
IRRC (binary)	Located inside an Irrigation Company	Not significant
CPRICE	Index of Crop Prices	Correlated with Year
ET	Elevation and location north, represent ET	Not significant

- Other variables were tested in the model but were dropped due to correlation with other variables or lack of statistical significance.
- Although crop types influence the amount of land irrigated and water used, POT or HVCROPS did not have a significant effect on PRICE.

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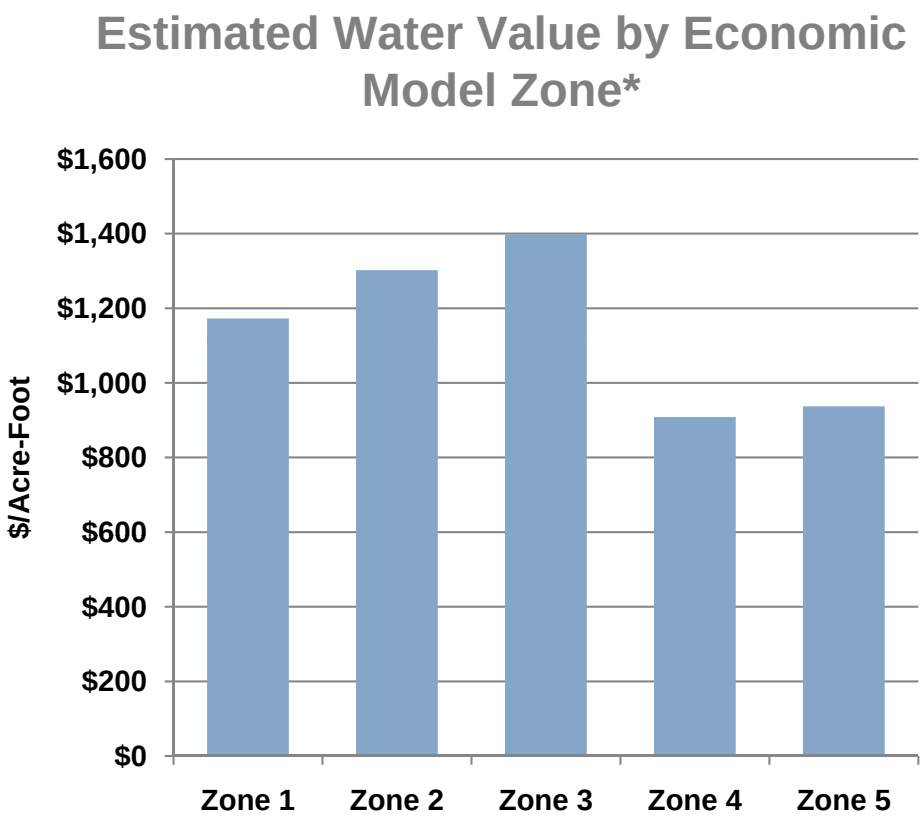
Economic Model Results

- The coefficients can be used to estimate the value of farm land and water in the region.
- The estimated average value per acre-foot (consumptive) in Zone 3 is approximately $1,400 and $908 in Zone 5 (2008).*
- The price of irrigated land also varies based on the distance to town and aquifer depth, among other factors in the economic model.

* This estimate assumes that 80% of the total agricultural land price appreciation is attributable to water and a farm with a 200 foot pump lift.



* Estimated assuming a uniform consumptive water use of 2 acre-feet per acre

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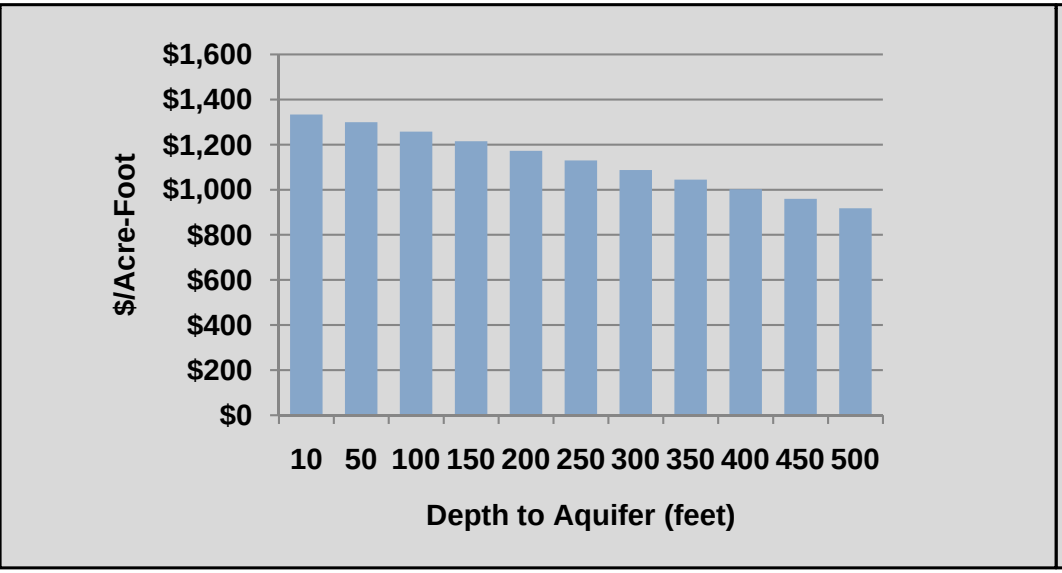
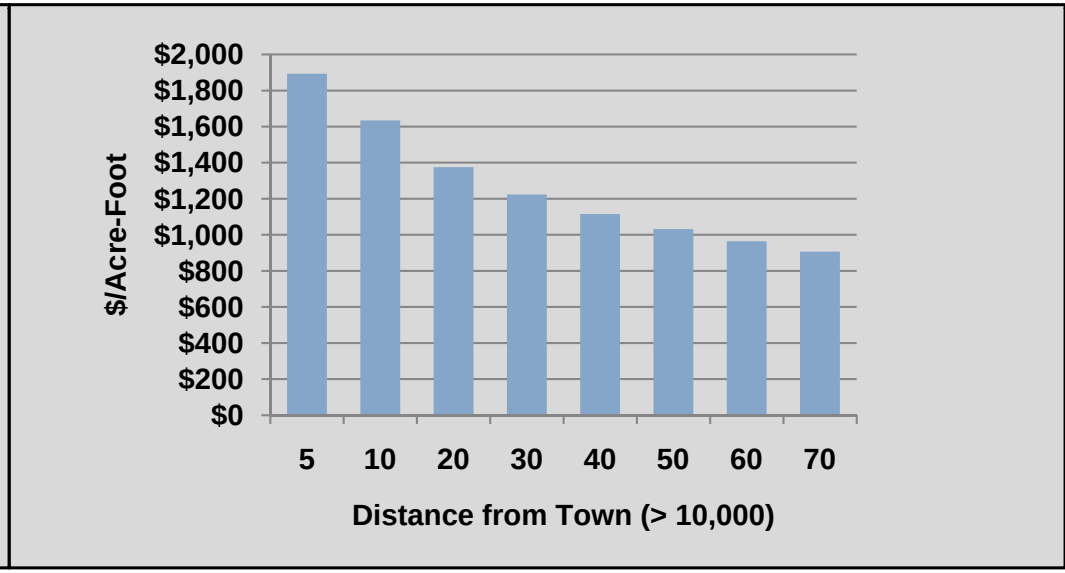
Economic Model Results

Change in Price per Acre

	Distance from Town (>10,000)						
Depth to Aquifer	**5**	**10**	**20**	**30**	**40**	**50**	**60**
50	$4,627	-$648	-$1,296	-$1,675	-$1,944	-$2,152	-$2,323
100	-$85	-$733	-$1,381	-$1,760	-$2,029	-$2,237	-$2,408
150	-$170	-$818	-$1,466	-$1,845	-$2,114	-$2,322	-$2,493
200	-$255	-$903	-$1,551	-$1,930	-$2,199	-$2,407	-$2,578
250	-$340	-$988	-$1,636	-$2,015	-$2,284	-$2,492	-$2,663
300	-$425	-$1,073	-$1,721	-$2,100	-$2,369	-$2,577	-$2,748
350	-$510	-$1,158	-$1,806	-$2,185	-$2,454	-$2,662	-$2,833
400	-$595	-$1,243	-$1,891	-$2,270	-$2,539	-$2,747	-$2,918
450	-$680	-$1,328	-$1,976	-$2,355	-$2,624	-$2,832	-$3,003
500	-$765	-$1,413	-$2,061	-$2,440	-$2,709	-$2,917	-$3,088

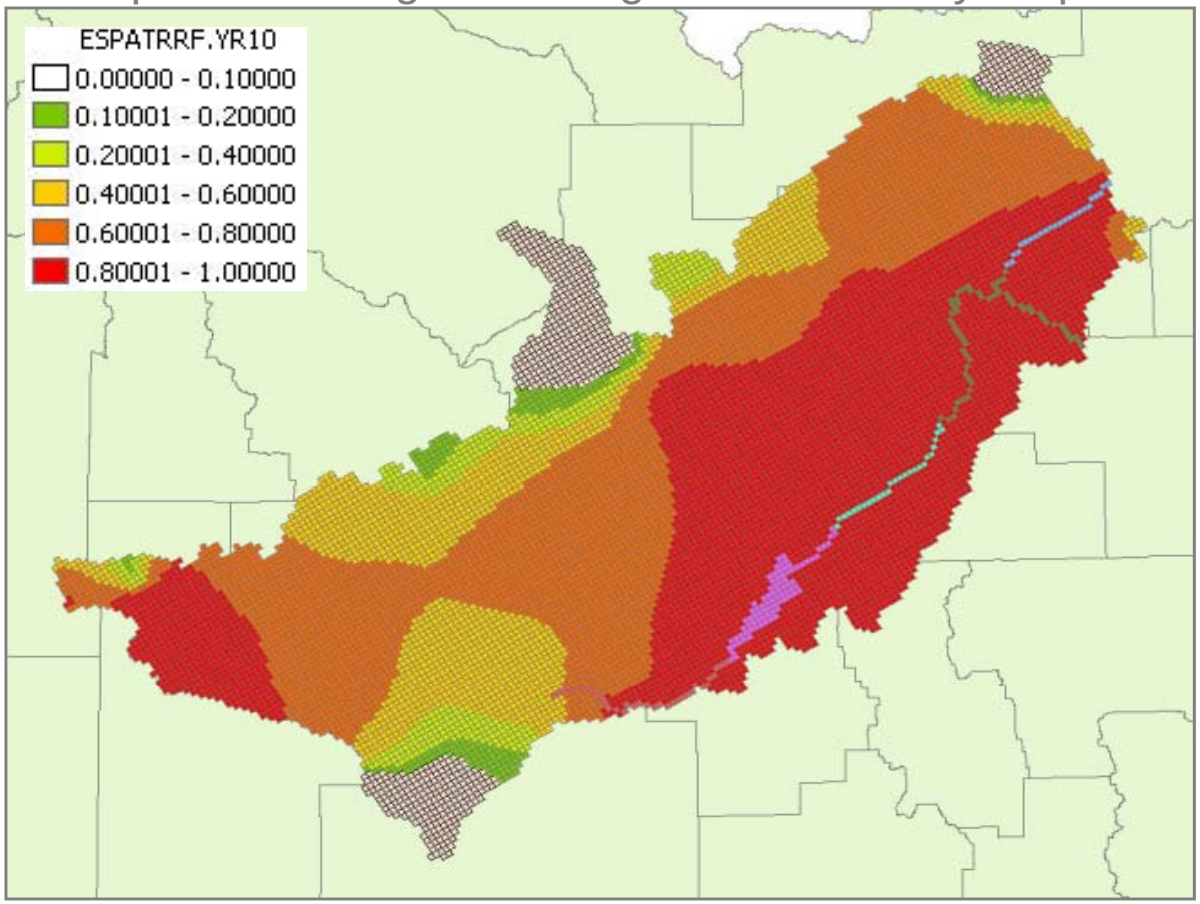




Economic Model Application

- Aquifer Response Functions
  - All groundwater eventually returns to the Snake River
  - All reaches are treated equally – “no target”?
  - Reach gains weighted according to priority, equitable distribution (upper, middle, lower)?
  - Timing of reach gains varies by location in the ESPA
- Application of the values from the Economic Model requires policy direction from the Committee.

Example of “no target” reach gains over a 10 year period.



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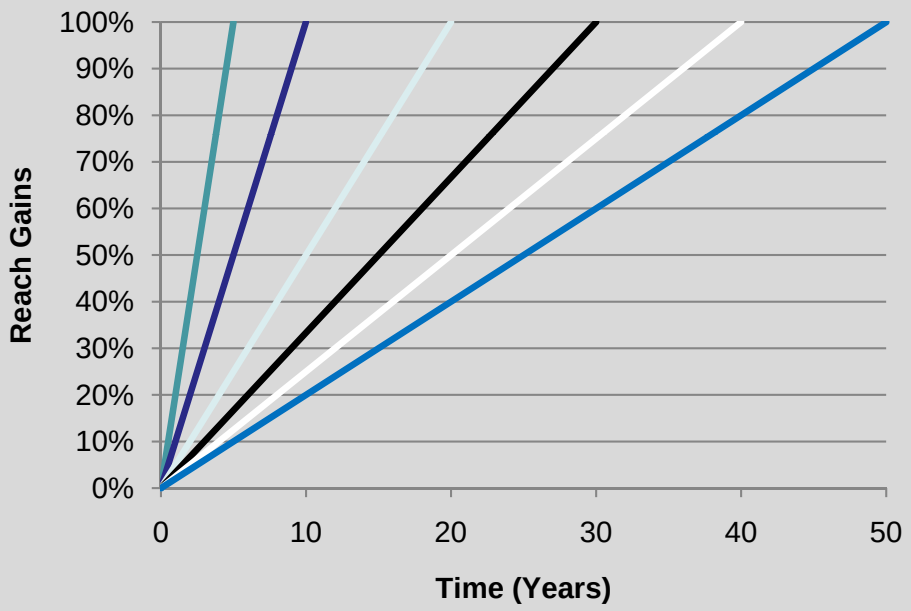
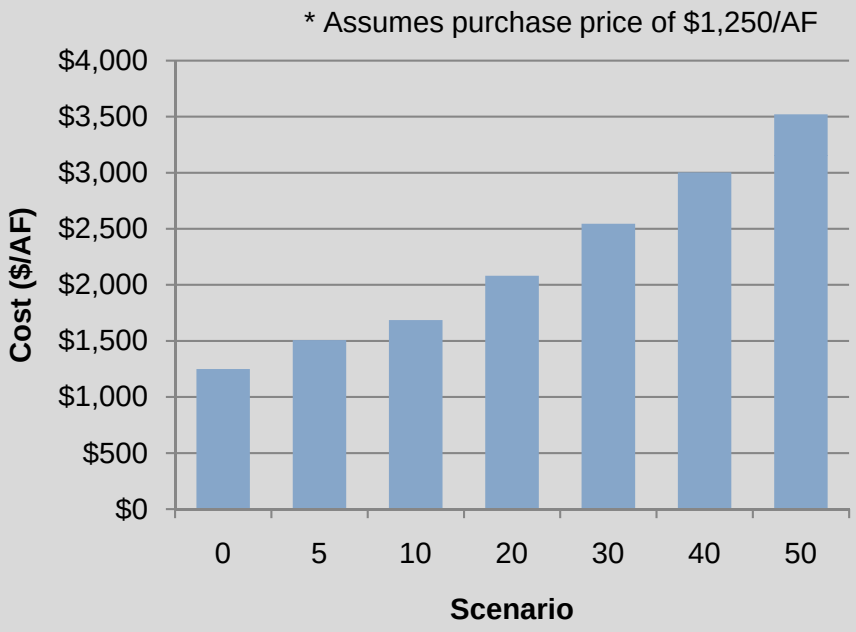
Economic Model Application

- Uniform Unit Value
  - Account for the Timing of Reach Gains
  - Management Options that Produce Reach Gains with a Shorter Timeframe are Preferred to those that Require More Time to Observe Gains
  - Discount AF Reach Gains (4.875%)
- Illustrative Example





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Demand Reduction – Permanent Acquisitions

- Medium Package Targets
  - Demand Reduction Emphasis
  - 250,000 AF of Demand Reduction (in addition to CREP)
  - Equivalent to125,000 acres of groundwater irrigated land

- No Target
- Upper
- Middle
- Lower

Estimated Direct Cost to Implement
$250 to $400 million

- Total Direct Costs will be lower if demand reduction is targeted to the Upper ESPA (Economic Model Zones 4 and 5).
- 125,000 acres represents approximately 30% of the groundwater irrigated acres in Zones 4 and 5.
- Reach gains primarily occur above American Falls.

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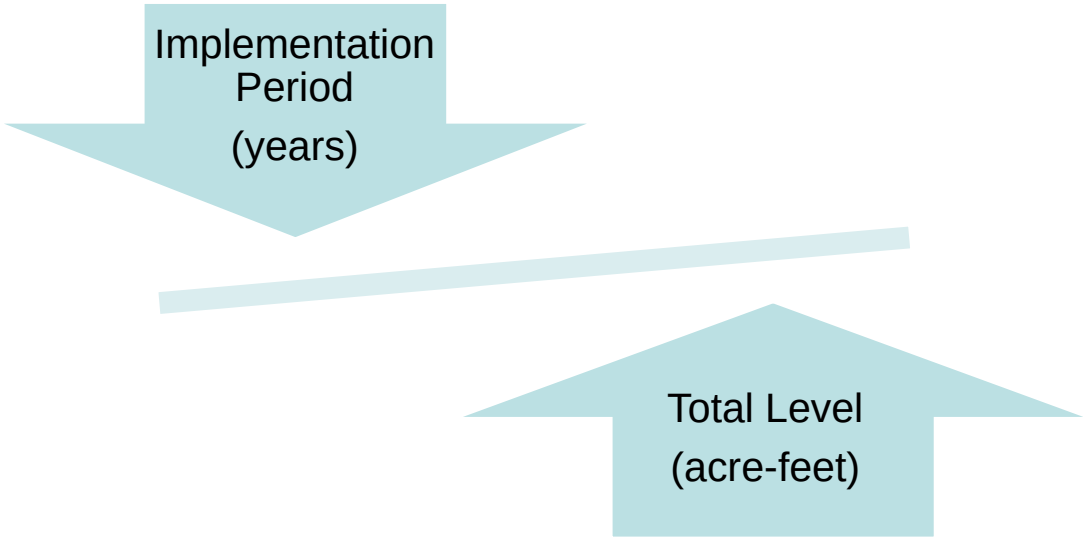
Demand Reduction – Permanent Acquisitions

- Approximately 35,000 irrigated acres sell each year within the ESPA through land transactions.
- At this rate, it would require 12 years to implement 250,000 AF through permanent acquisitions (assuming one-third of marketed land is acquired for this purpose).
- The total cost of demand reduction will vary according to the level of demand reduction and the implementation period.



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Demand Reduction – Other Options

- Potential Leasing Tools:
  - Full Season: Cease irrigation for the full irrigation season.
    - Commonly used
    - Crops – pasture, hay, grains
  - Partial Season: Cease irrigation for part of the irrigation season.
    - Gaining in application – primarily instream/mitigation uses
    - Crops – pasture and hay
  - Crop Mix: Change crop rotation to increase the percentage of irrigated land planted to crops with lower evapotranspiration levels.
    - Not well tested
    - Contract Crops; Rotation Crops
    - Verification can be difficult
  - Dry Year Option
    - Commonly used
    - Forecasting hydrologic conditions

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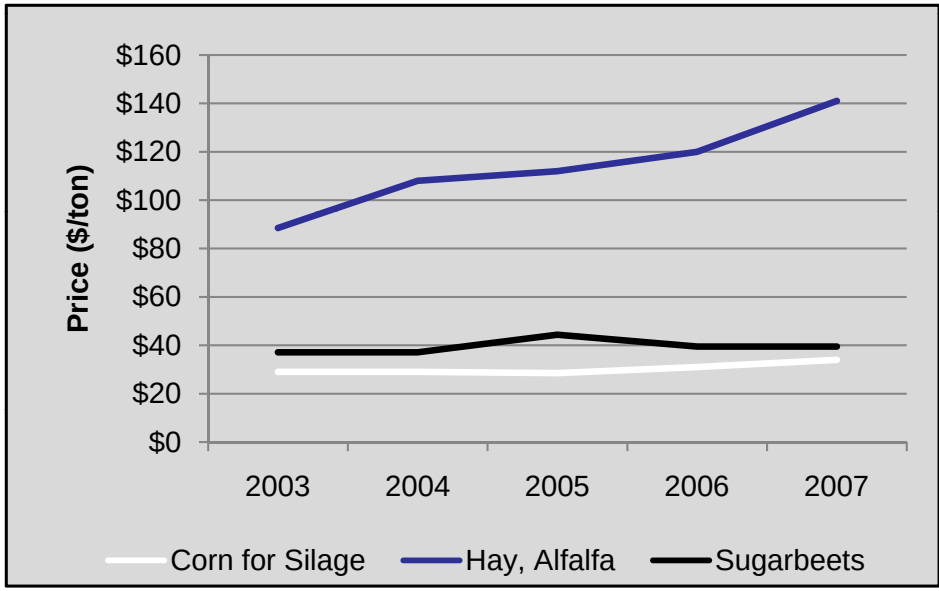
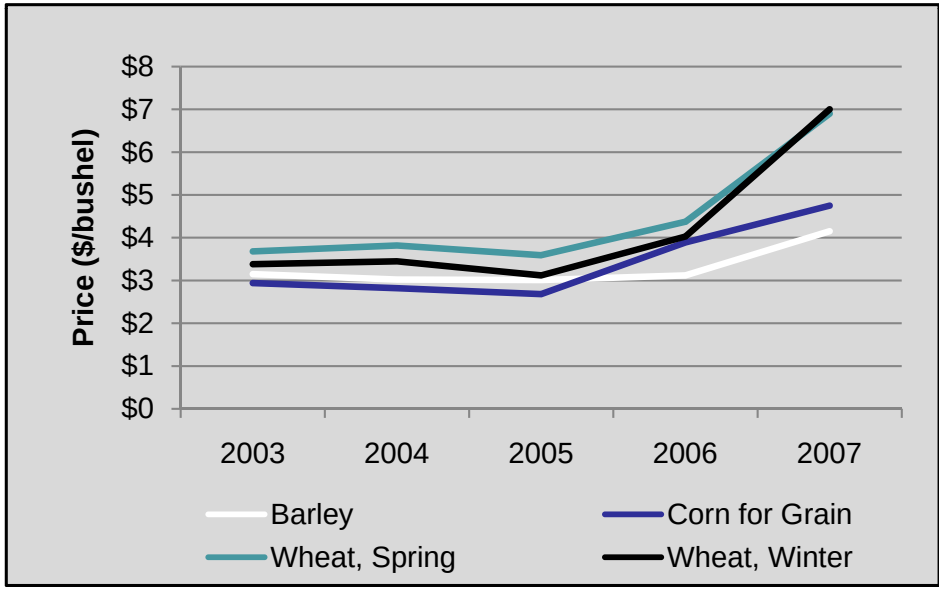
Demand Reduction – Other Options

- The cost and volume of water available for lease will depend upon overall water supply conditions, crop prices, and production costs
- Water leases in other regions have predominantly come from hay and pasture
- Water leasing can be more expensive in the long-term due to fixed costs and labor considerations
- "Tight" markets for feed crops will affect participation and cost
- Will require flexibility in the annual budget or the annual target

- **Crop prices have been increasing in Idaho…**





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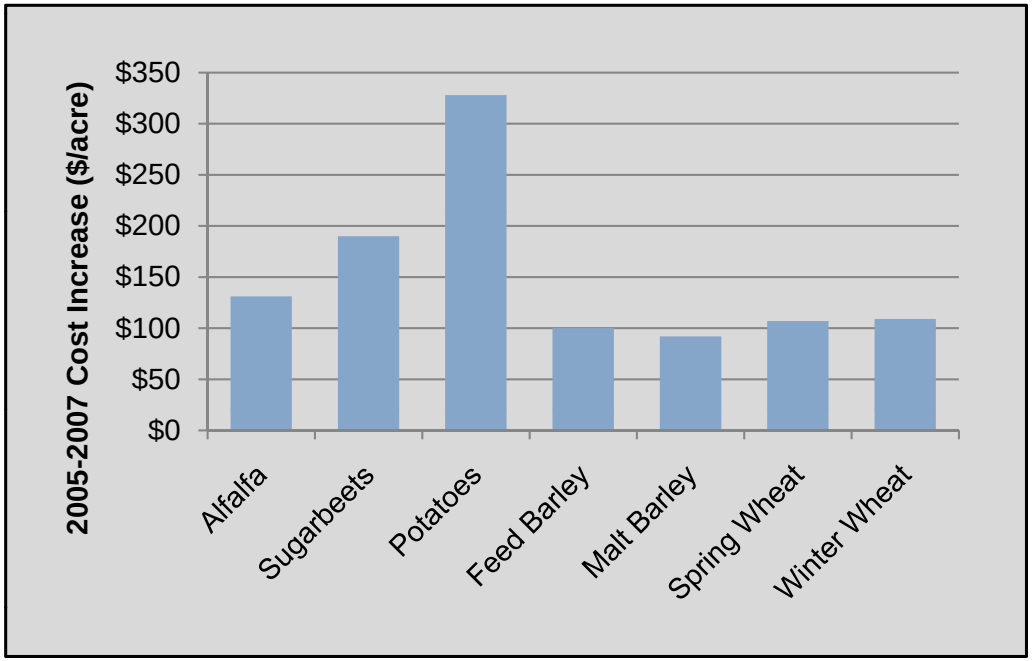
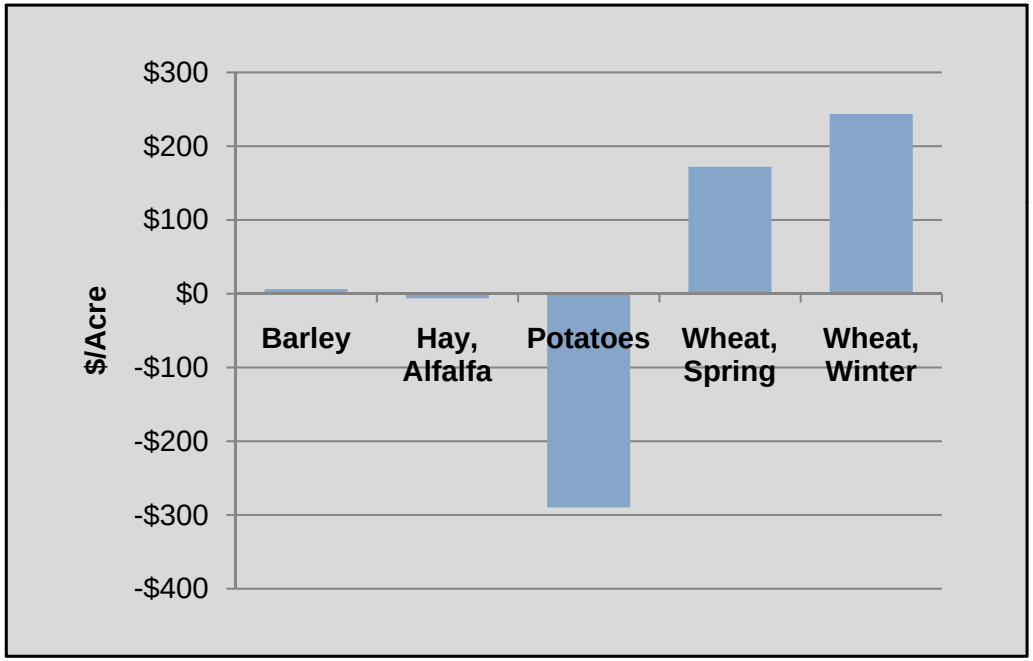
Demand Reduction – Other Options

- So have production costs…





- Net revenue is what matters

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Demand Reduction – Other Options

- A target of 250,000 AF annually exceeds the scope of other existing leasing programs
- Prices generally range from $30 to $175 per acre-foot depending upon water year, lease terms, and location. Contracts generally require reduced irrigation – Deschutes is an exception.
- Using the Klamath example, the average price per acre is $175 per acre. Enrolling 125,000 acres at this price would require an annual budget of $22 million.

	Klamath Basin	Deschutes Basin	Yakima Basin	Dungeness Basin	Lostine Basin
Average Precip. April-Sept (inches)	3.75	3.95	2.59	5.19	7.41
Irrigated Land (Acres)	480,000	164,000	450,000	5,500	5,200
Percent Permanent Crops	0.0%	0.0%	40.0%	10.0%	0.0%
Avg. Alfalfa Hay Yield (tons/acre)	6.0	4.5	4.9	7.0	5.0
Lease Terms	Annual	Annual	Annual (dry year)	Partial Season	Partial Season
Volume Leased (Acre-Feet)					
2001		8,793	17,737 (dry year)		
2002		7,840	0		
2003	54,192	15,715	1,864	1,397	
2004	25,648	23,668	1,277	1,348	
2005	41,346	24,400	47,356 (dry year)	1,420	1,814
2006	18,507	29,203	1,048		1,814
Avg. Lease Price ($/Acre-Foot)	$71 (groundwater); $78 (dryland)	$7	$115 (dry year); $32 (normal year)	$175	$75 - $100

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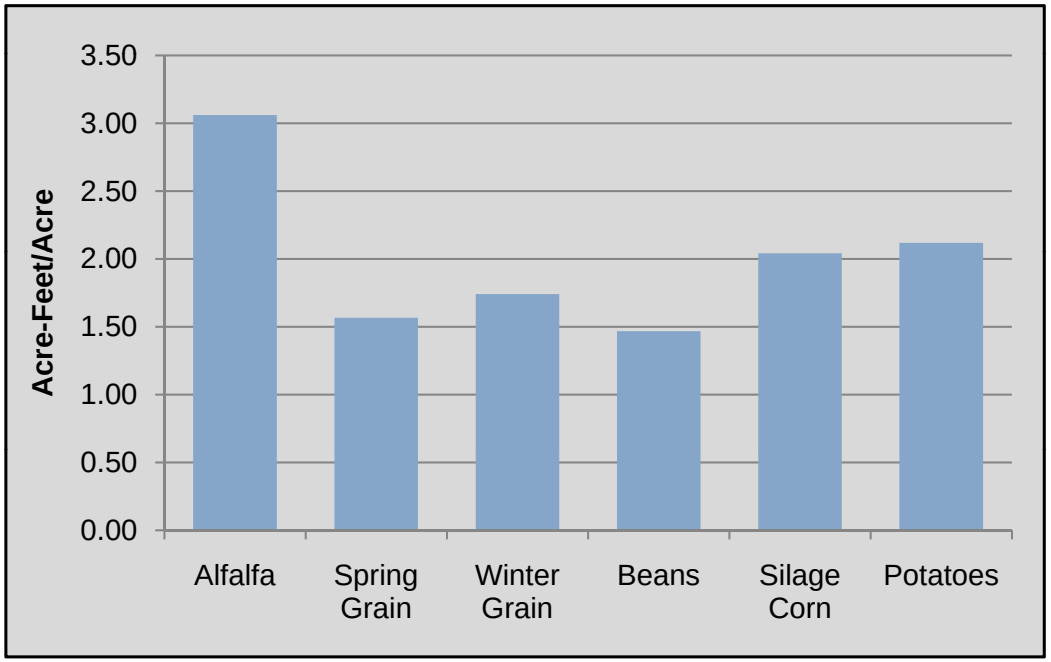
Demand Reduction – Crop Mix

- Change crop rotation to increase the percentage of irrigated land planted to crops with lower evapotranspiration levels.
- Reducing annual alfalfa production would be the likely goal of the program.
- May be difficult to change contract crop acres.
- Payments would likely need to extend 5 to 10 years to cover the full crop rotation period.
- Program verification would be a challenge.



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Demand Reduction – Crop Mix (Example)

- Before: 5 year rotation (4 alfalfa, 1 grain)
- After: 5 year rotation (3 alfalfa, 2 grain)
- Cost per acre-foot "saved" would be expected to vary according to the relative price of alfalfa and grain crop.

Crop	Units	Yield	Breakeven Price	Current Price	Net Revenue ($/acre)
Alfalfa	Tons	7	$97.80	$141.00	$302
Spring Wheat	Bushels	115	$4.96	$6.90	$223
Winter Wheat	Bushels	125	$4.71	$7.00	$286

Alfalfa Price	Grain Price	Cost ($/AF)
$141	$6.90	$53
$120	$5.50	$62
$110	$4.50	$93
$105	$4.00	$108
$130	$6.00	$71
$150	$7.50	$49

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