

Stream Water Allocation Modeling



32nd Annual Governor's Water Conference &
9th Annual OWRRI Water Research Symposium

Norman, OK
2011



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Agenda

- Why is the OWRB using stream water allocation models?
- Are other States using similar models?
- What is a stream water allocation model?
- How are the models being used by the OWRB?
- Relevance and future work



Why stream water allocation models?

The OWRB Stream Water Allocation Modeling Program was initiated in 2009

Models are implemented as a **comprehensive water planning tool** for the adjudication and effective management of water rights in Oklahoma

In Oklahoma stream water is publicly owned and subject to appropriation by the OWRB

The OWRB evaluates applications based on:

1. A present or future **need** for water must exist

2. Amount of water requested must be **available**

3. Use of water must **not interfere** with other water rights or uses

Stream Water Allocation Modeling

The statewide program allows estimating water reliability & identifying potential interference of water rights under various flow conditions

Why stream water allocation models?

Traditional Approach

- Availability relies on averaged **runoff from the 1980's**
- Does not identify **interference between water rights**
- Provides **limited information** to permit holders and applicants

Watershed Model

$$\begin{array}{r} \text{Average Runoff} \\ - \text{Appropriations} \\ - \text{Reservoir Dependable Yield} \\ - \text{Domestic Use} \\ \hline \text{Available Water} \end{array}$$




OWRB Stream Water Allocation Modeling

Provide scientific-based information to managers and citizens to answer:

- Is there water **available** in the amount needed?
- How **reliable** is the flow on a **seasonal or monthly** basis?
- Which **water rights are affected** when water is scarce?
- Are there any **fully appropriated areas** in the basin?
- Is there enough water to approve **an inter-basin transfer**?

Are other States using similar models?



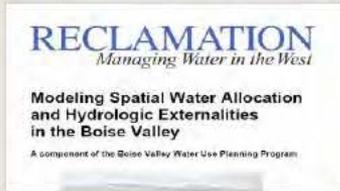
TEXAS

Water Availability Model (WAM) for water-rights management (2001)



DELAWARE

Used in limited form for stream water management



IDAHO

Bureau of Reclamation, management of reservoirs on Snake River



COLORADO

Colorado River management; many cities & irrigation districts

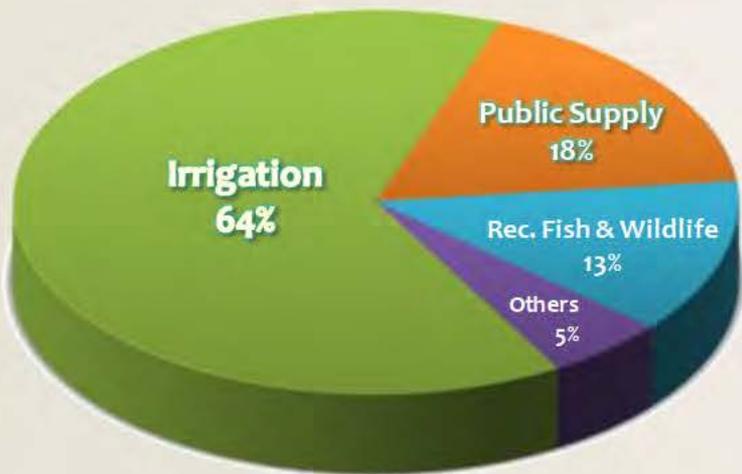


CALIFORNIA

Imperial Valley irrigation district

Allocation models have also been used by cities, small neighborhood coalitions, private and government hydropower operators, conservation and environmental groups, and others

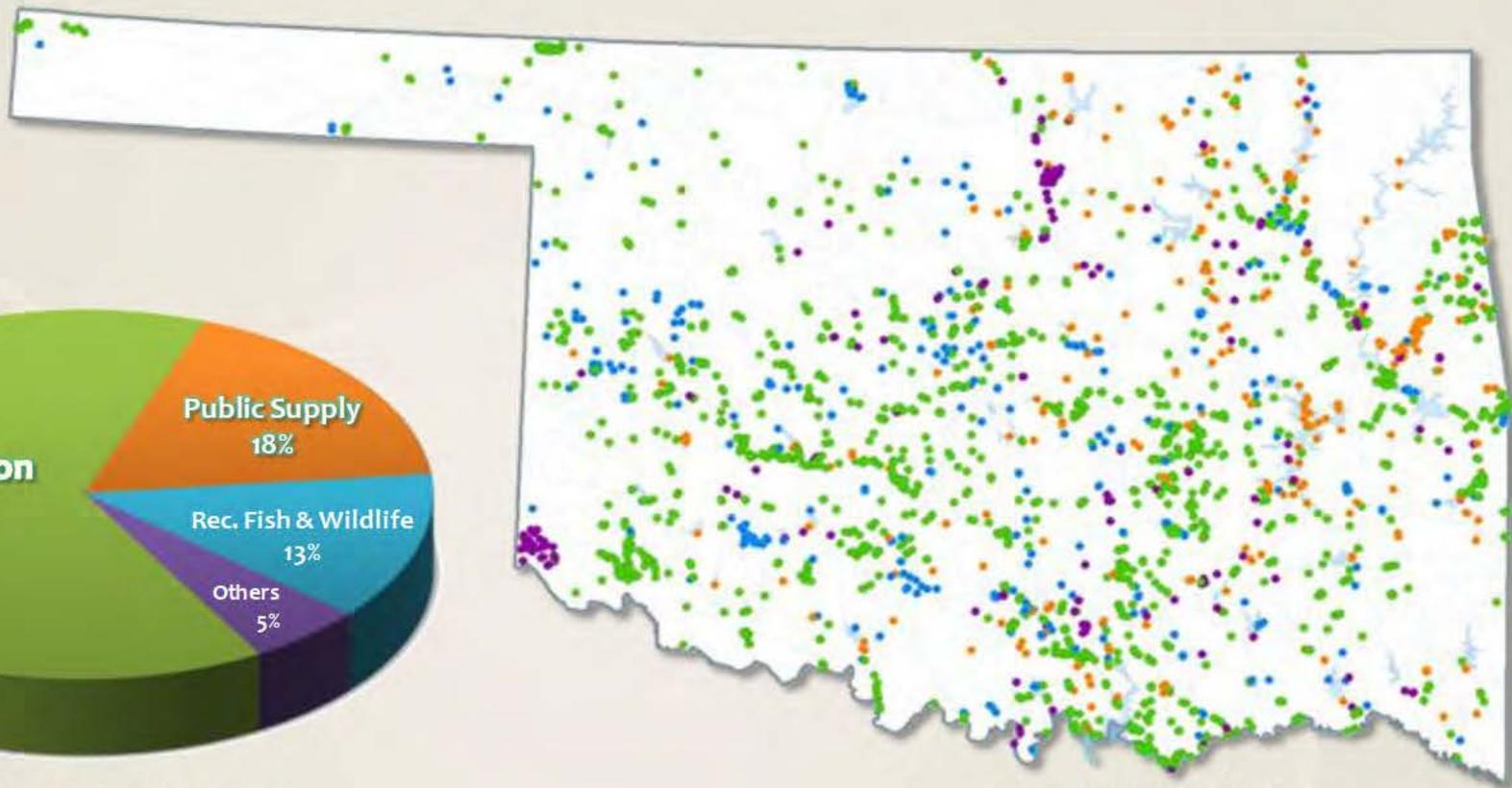
Active stream water rights



Percentage of active permits in Oklahoma

2,862

Stream Water Rights



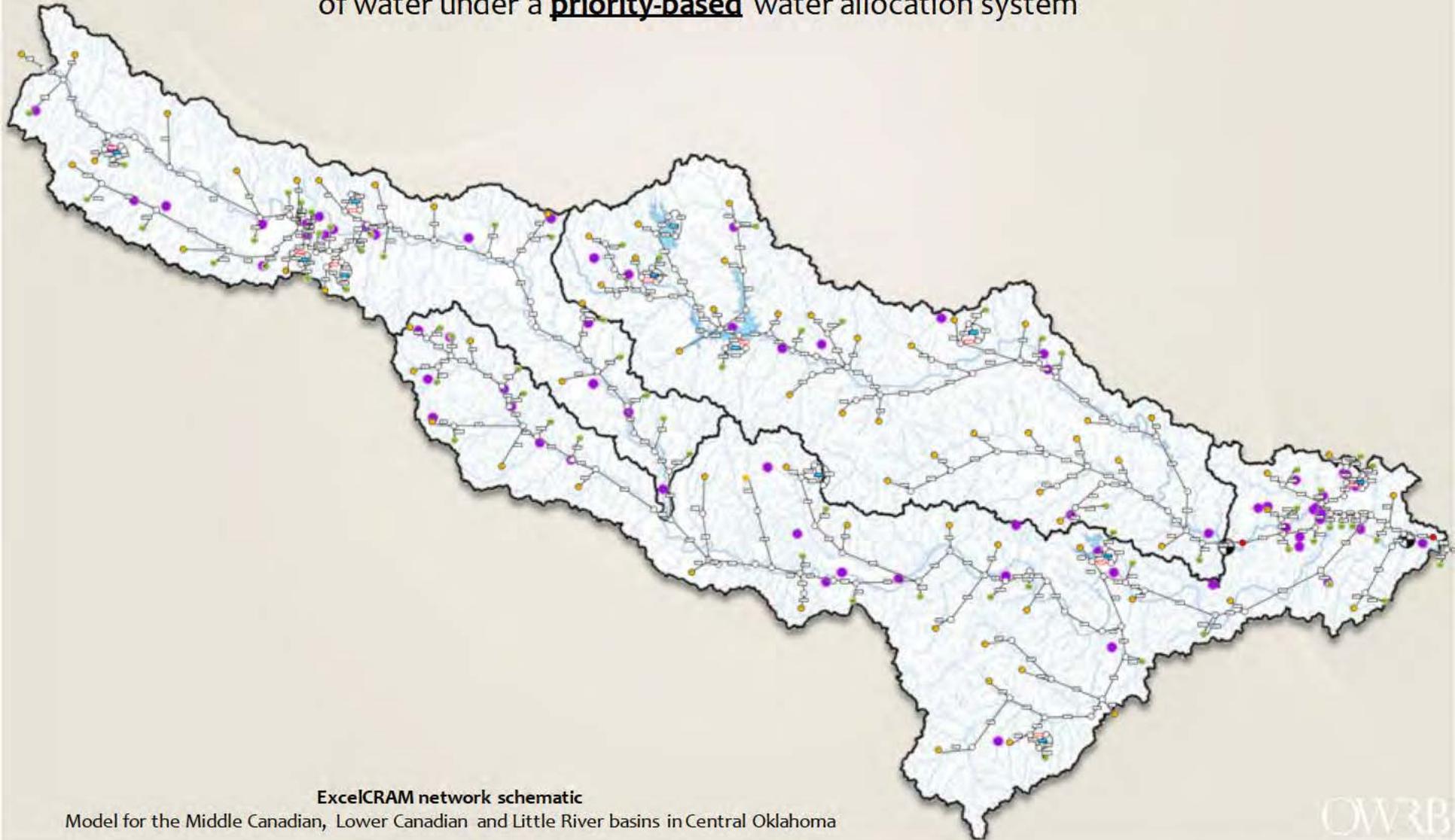
Active Surface Water Rights, 2011

Stream water allocation models facilitate the **management** of **active** permits and the evaluation of **new permit applications** to **ensure a reliable supply** to all permit holders

What is a stream water allocation model?

Software: **Central Resources Allocation Model (CRAM)**

Network-flow-algorithm in Microsoft Excel® that simulates management of water under a **priority-based** water allocation system



ExcelCRAM network schematic

Model for the Middle Canadian, Lower Canadian and Little River basins in Central Oklahoma

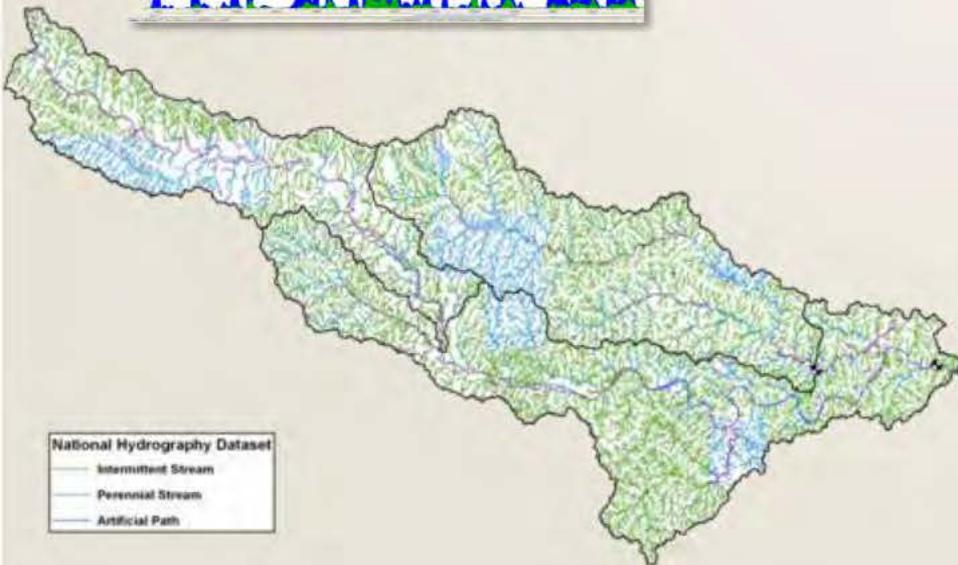
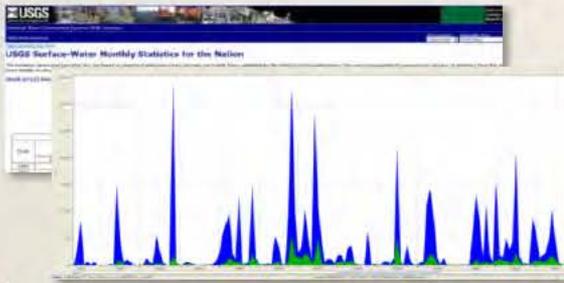
Data included in the models

Inflow

$$\text{Naturalized Flows}^* = \text{Gauged Flows} + \text{Water Use}$$

- Statistical analysis of gauge data
- Separate baseflow and runoff
- Use NHD to distribute baseflow and runoff

- Reported water use from surface water rights (QA/QC)
- Convert annual values to monthly using consumptive patterns (OCWP)
- Reservoir effective evaporation and releases
- Return flows from consumptive uses



OKLAHOMA WATER RESOURCES BOARD
Planning and Management Division
3000 N. Chastain Boulevard
Oklahoma City, OK 73105-0000
955-500-8900

OWRB No. 050094

2010 ANNUAL SURFACE WATER USE REPORT
- WILSON DOYLE -
FEB 05 2011
5043 9200
Oklahoma Water Resources Board

Page 1 of 5

WILSON DOYLE
3023 N. 28th St
HOLDSVILLE, OK 74848-8001

Water Right Information: SEARCHED, COUNTY, TOWNSHIP, RANGE, SECTION

Legal Description of Diversion Points

Legal Description of Land

Amount of Water Diverted: 24.0 Acre Feet / Year

If you wish to CANCEL this water right, check this box:

1. Please complete ONLY ONE of the following:
A. Check this box if no water was used:
OR
B. Purpose used in gallons per acre-ft: X acres pumped: X AGI received per acre-ft: (Total gallons used)
OR
C. Acres irrigated: 100 X times irrigated: 4 X inches per application: 2K X 10 = 445 (AGI's total used)
OR (if Available)
D. Meter Number: (December 31, 2010) (January 1, 2010) (Total gallons used)

2. Other group who owns/operates/controls this water right: (Name)
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Features and data included in the models

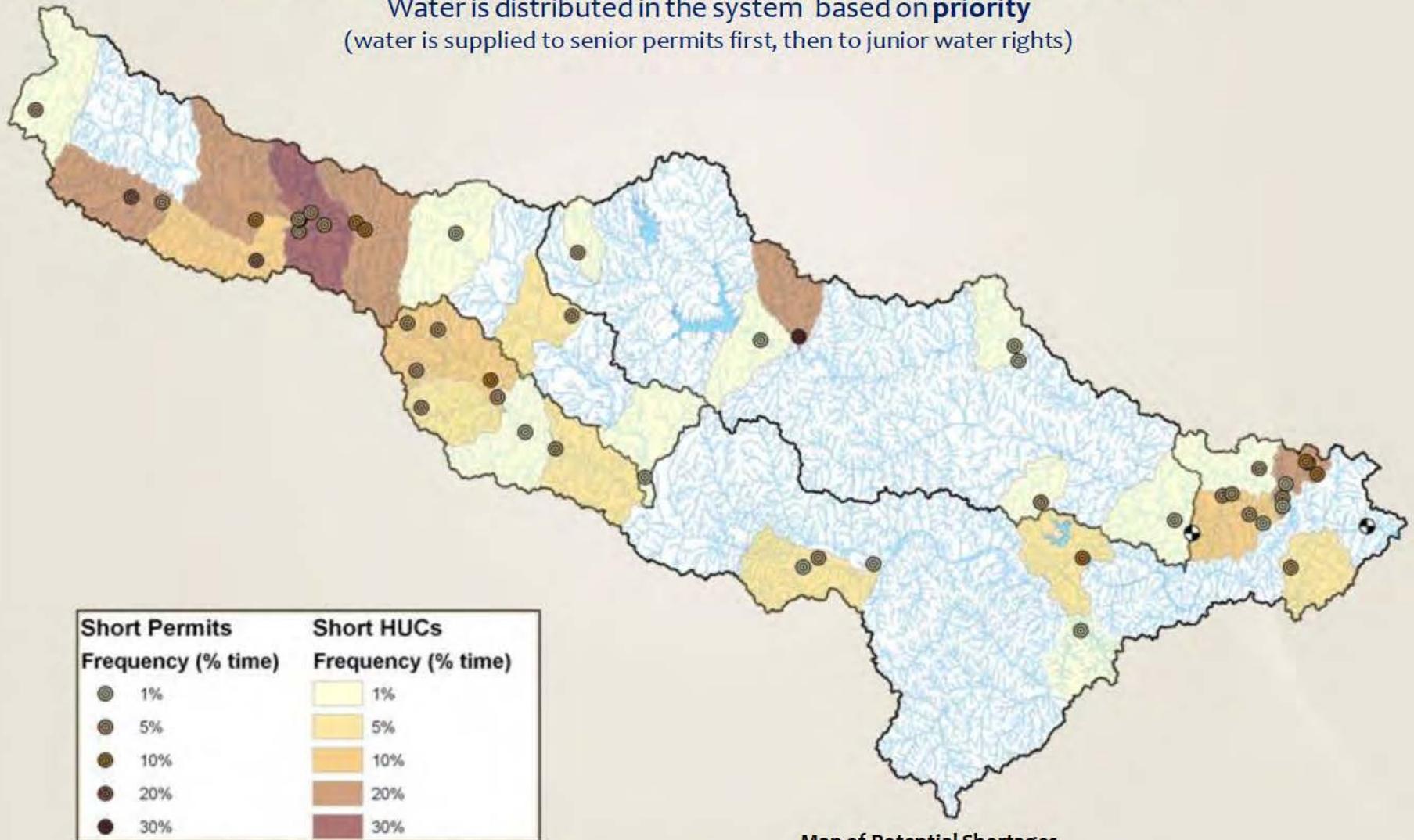


Case Study: Water Availability & Potential Shortages

Scenario 2:

All water rights use their maximum permitted amount every year (1950-2011)

Water is distributed in the system based on **priority**
(water is supplied to senior permits first, then to junior water rights)



Map of Potential Shortages

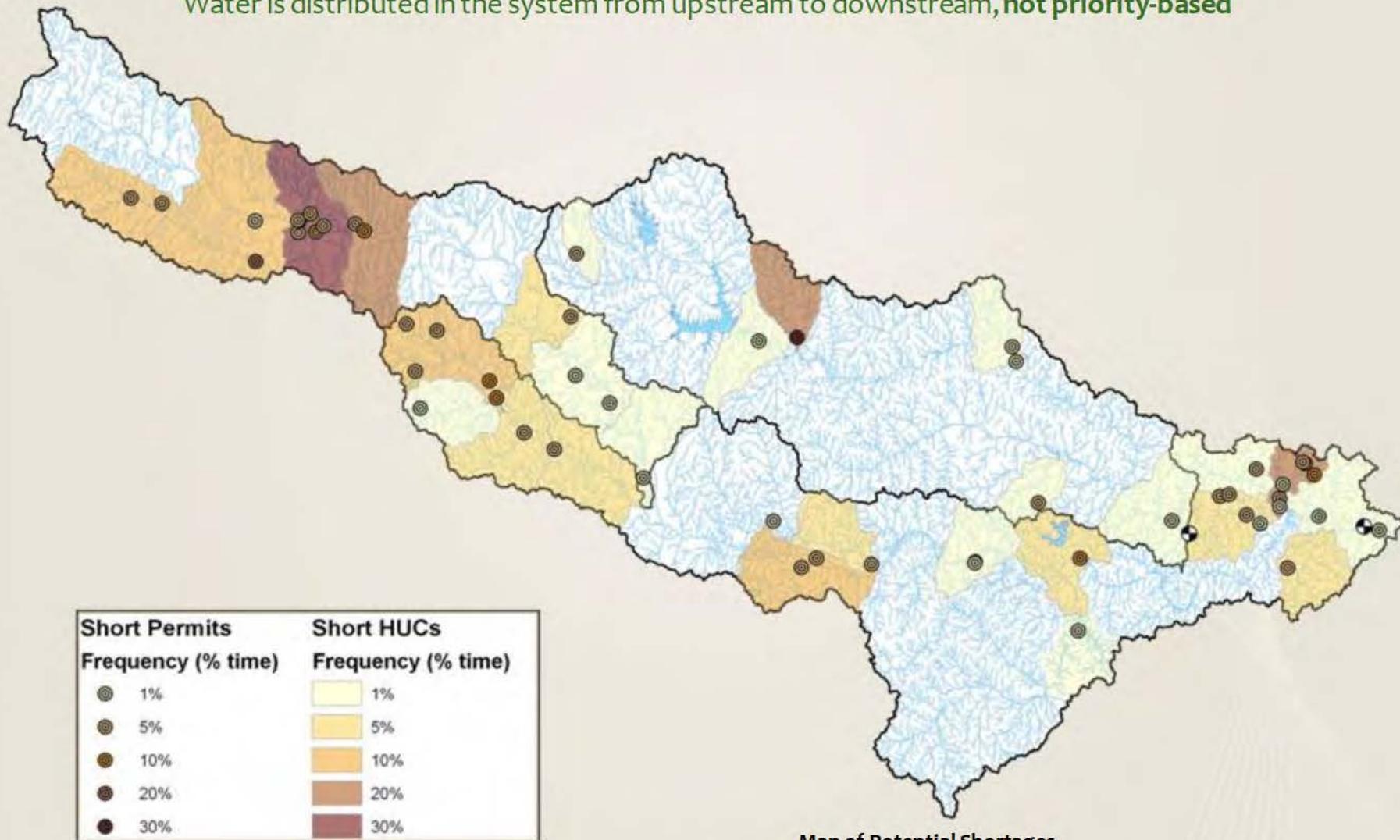
Middle Canadian, Lower Canadian and Little River Basins

Shortages reflect active water rights under historic flow conditions (1950 -2011)

Case Study: Water Availability & Potential Shortages

Scenario 4:

All permits use maximum permitted amount every year (1950-2011)
Water is distributed in the system from upstream to downstream, **not priority-based**

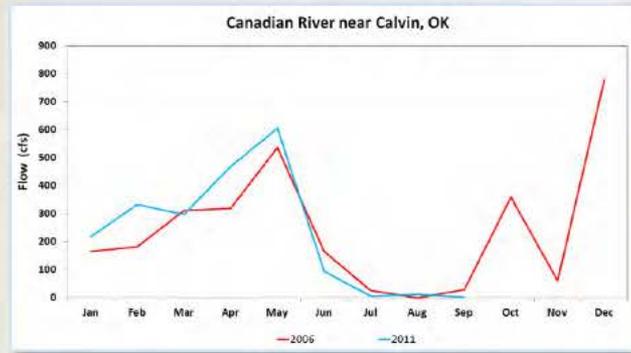


Map of Potential Shortages

Middle Canadian, Lower Canadian and Little River Basins
Shortages reflect active water rights under historic flow conditions (1950-2011)

Case Study: Drought Analysis

Model simulations use historic flows and active water rights to identify potential shortages that permit holders would experience under the specified flow conditions



Observed flows at the USGS gauge show similar flow conditions in 2006 and 2011.

Similarities allow the OWRB to identify water rights that could potentially experience water shortages, to prevent interference and encourage water-use efficiency

Shortages in the Basin					
Total Shortages (AF):					16,574
Permits with Shortages:					24
Enter amount (AF) to use as threshold:					500
+ 7 permits have shortages equal or greater than 500 AF +					
Demand #	Permit	Allocated (AF)	Purpose	Shortages (AF)	Months of Shortages
5	19900052	1,750	Irrigation	230	1
6	20030008	800	Irrigation	179	1
7	20080034	540	Irrigation	121	1
8	19840062	730	Irrigation	188	1
11	19870059	584	Industrial	153	7
12	20030037	1,100	Irrigation	260	1
13	20020018	1,985	Irrigation	657	4
18	19830021	150	Irrigation	12	1
20	19970592	27,000	Power	1,252	2
30	19870583	8,600	Power	3,858	11
35	19830069	90	Irrigation	85	7
38	19950481	84	Irrigation	53	7
37	19780011	3,150	Public Supply	1,379	11
38	19950095	630	Irrigation	369	7
45	19850273	26	Irrigation	22	6
47	19850366	126	Rec Fish & Wildlife	132	7
48	19950537	21,600	Public Supply	4,900	8
53	20080035	1,775	Irrigation	365	2
65	19810133	2,200	Public Supply	1,214	4
88	19940003	25	Irrigation	22	7
74	19960012_2	750	Irrigation	525	4
77	20080034_2	540	Irrigation	121	1
79	19840062_2	730	Irrigation	85	2
80	20030037_2	1,100	Irrigation	335	2



Simulation Results Scenario # 4

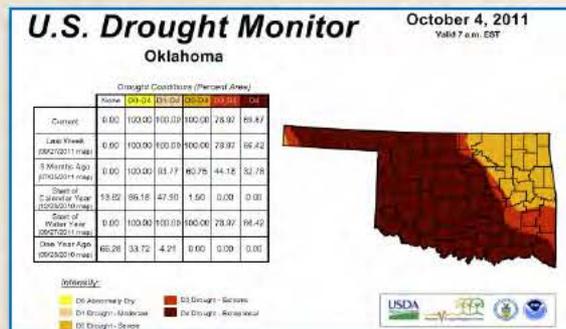
Total Basin Shortages in acre feet													
Shortage in acre-feet													
YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
2006	1,040	1,068	554	742	121	1,558	4,835	2,812	3,195	180	825	-	16,532

The OWRB is using stream water allocation models to:



1. Perform location-specific analysis

- Determine **water reliability** at any location in the basin
- Evaluate **new permit applications**



2. Manage the resource during low-flow conditions

- Identify **potential shortages** for water rights
- Pre-drought warning** for water rights to manage interference between senior and junior water rights
- Ensure reliability** and prevent over-allocation of water

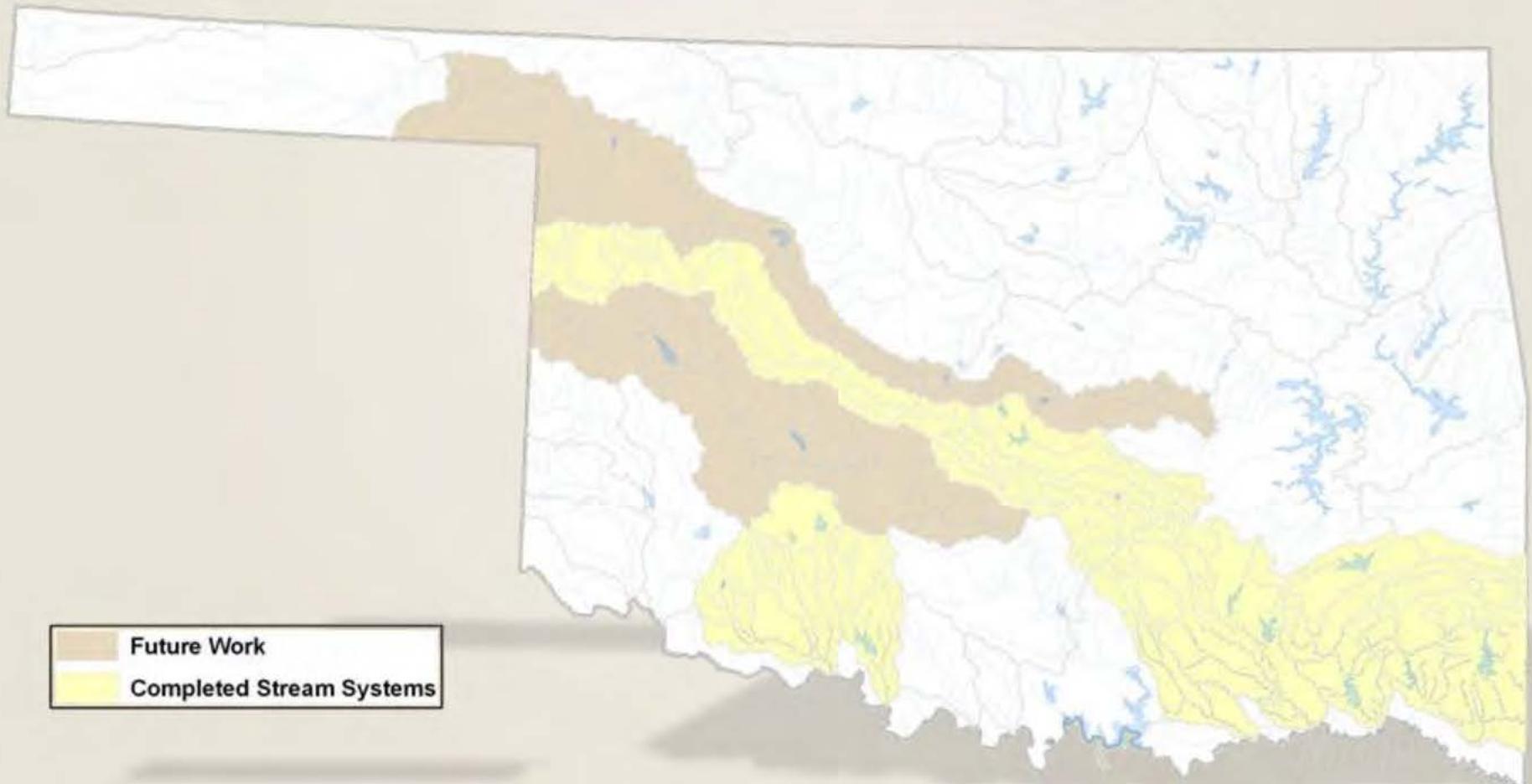


3. Evaluate water policy scenarios

- Inter/intra basin transfers
- Inter-state stream Compacts
- Instream flows

2012 OCWP recommendation for the State Legislature on water supply reliability:

“**Develop stream water allocation models** on all stream systems within the state to **assess** water availability at specific locations, **manage** junior/senior surface water rights under various drought scenarios, **anticipate** potential interference between users, and **evaluate** impacts of potential water transfers”





State of Oklahoma
OWRB
WATER RESOURCES BOARD
the water agency

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