Maine Geological Survey:
Water Use, Supply and Demand

Ryan Gordon, Hydrogeologist

2000's Water Withdrawal Reporting Program

Maine Revised Statutes

Title 38: WATERS AND NAVIGATION

Chapter 3: PROTECTION AND IMPROVEMENT OF WATERS

Article 4-B: WATER WITHDRAWAL REPORTING PROGRAM
HEADING: PL 2001, C. 619, §1 (NEW)

§470-A. DEFINITIONS

As used in this article, unless the context otherwise indicates, the following
[2001, c. 619, §1 (NEW).]

Water Withdrawal Reporting Program
2006-2007 Annual Report, Maine DEP

Water Withdrawal Data

Reported Water Withdrawals by Type

Type of Use	Withdrawals Reported (millions of gallons)				
	2003	**2004**	**2005**	**2006**	**2007**
Water Utilities	33,800	34,400	33,500	33,600	29,355
Paper Mills	70,000	66,000	63,000	57,900	64,919
Agriculture	861	719	622	514	1,691
Snow Making	590	559	606	863	537
Bottled Water	365	448	440	699	646

Water Use Data and Research (WUDR) Program

USGS and MGS partnership began in 2015

Goal is to help states help the USGS – 5-year National Water Census

Currently beginning work on our third USGS Cooperative Agreement

MGS projects funded by the USGS program:

- 2016: Development of our Water Use Workplan

- 2017-2018: Agricultural water use (Irrigation and Livestock)

- 2019-2020: Domestic water use and public utilities

- 2021-2022: Industrial water use

Maine's Annual Water Use in 2015

Example uses:
- Industrial - 66 billion gallons
- Domestic - 24 billion gallons
- Aquaculture - 20 billion gallons
- Irrigation - 7 billion gallons
- Bottled water - 1 billion gallons
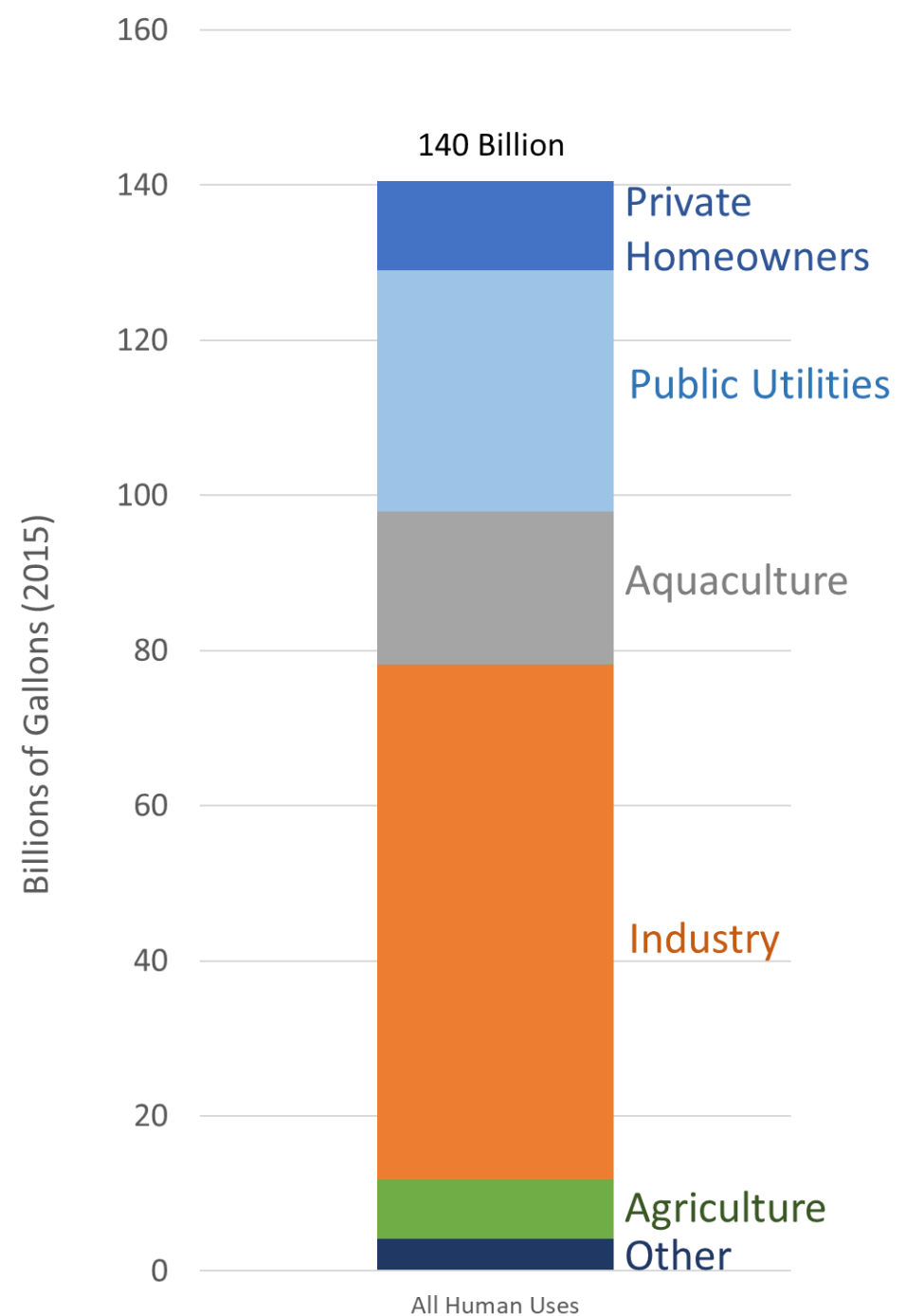
Agricultural water use survey and irrigation demand model

2017-2018 WUDR project

Part 1: Survey results published in MGS Circular 18-9

Part 2: Gridded estimates of irrigation water demand made for 2016-2018

Ag Part 1:

CIRCULAR NO. 18-9

Title: *Survey of Agricultural Water Users in Maine: Results for Calendar Year 2016*

Author: *Ryan P. Gordon, Amber H. Whittaker, and Robert G. Marvinney*

Date: *May 2018*

Survey response rate

County	farms contacted	total survey responses	response rate
Androscoggin & Sagadahoc	212	54	25%
Aroostook	207	43	21%
Franklin	136	32	24%
Kennebec	160	59	37%
Penobscot	200	53	27%
Somerset	68	25	37%
Waldo	115	40	35%
Washington	203	8	4%
York	146	5	3%
TOTAL	**1,447**	**319**	**22%**

Irrigated farms reporting

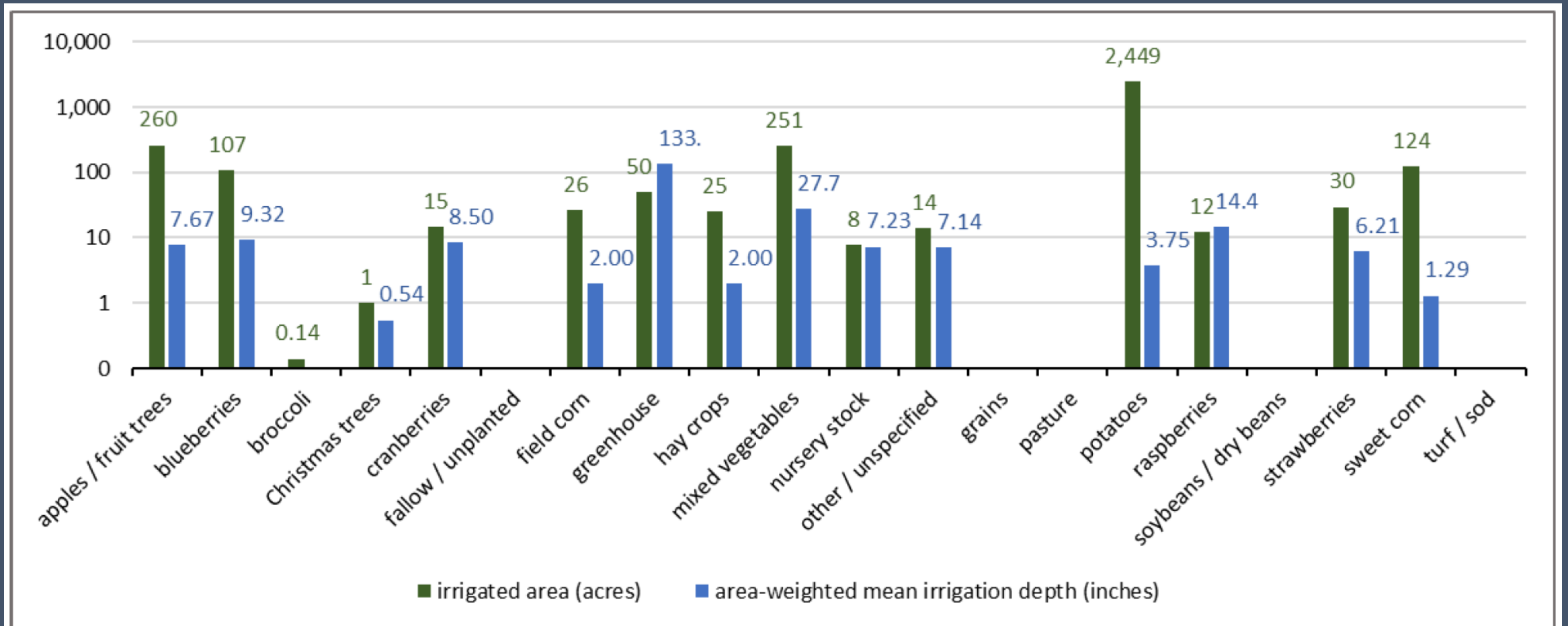| County	USDA 2012 irrigated farms	farms reporting an irrigated crop	percent of USDA irrigated farms
Androscoggin & Sagadahoc	158	26	16%
Aroostook	89	12	13%
Franklin	37	16	43%
Kennebec	90	13	14%
Penobscot	129	18	14%
Somerset	60	12	20%
Waldo	118	9	8%
Washington	75	6	8%
York	152	2	1%
TOTAL	**908**	**114**	**13%**

Survey results

Figure 2. Total irrigated acres of each crop type reported by survey respondents, and area-weighted mean inches of water applied to each type of irrigated crop in all of 2016. Vertical axis scale is logarithmic.
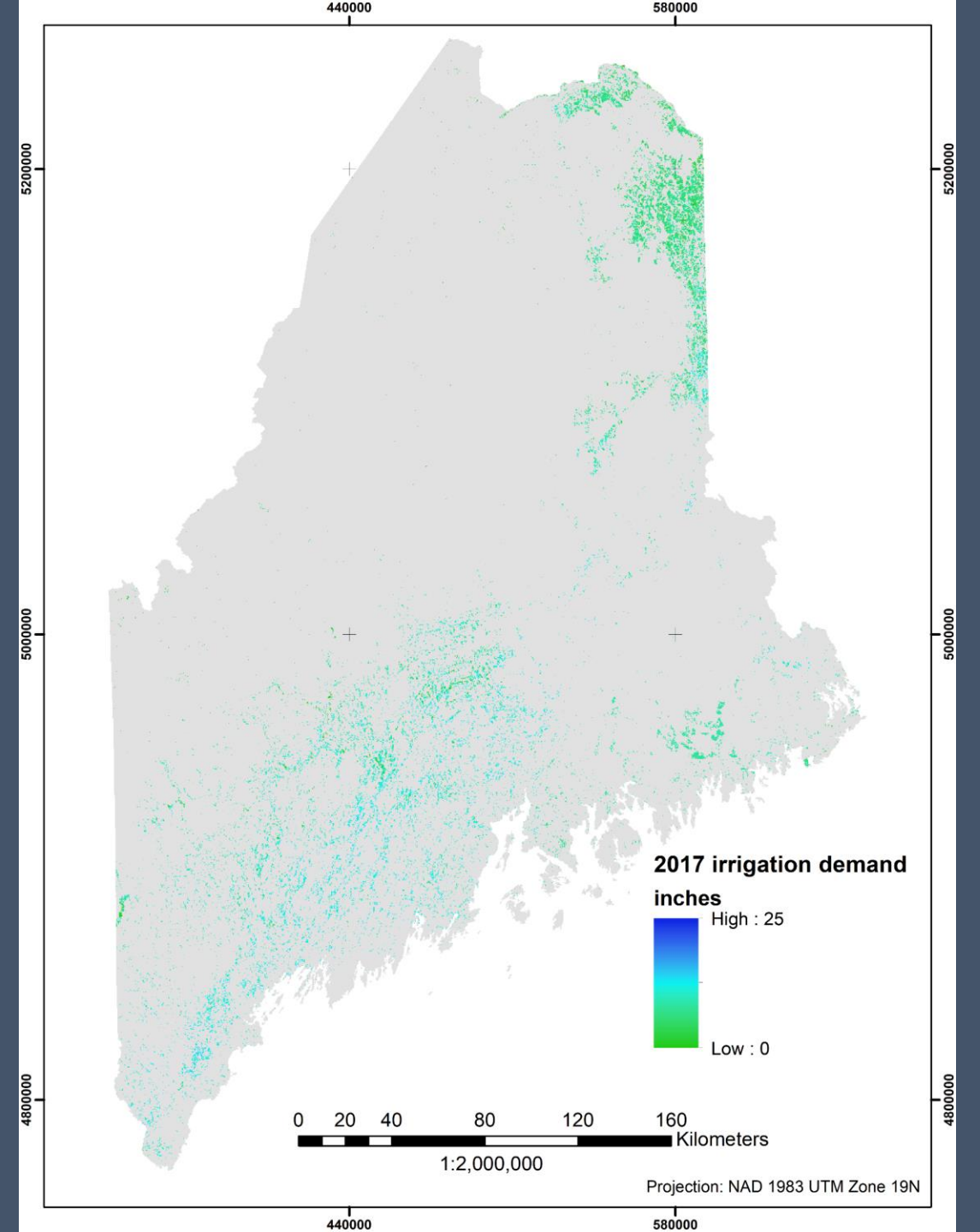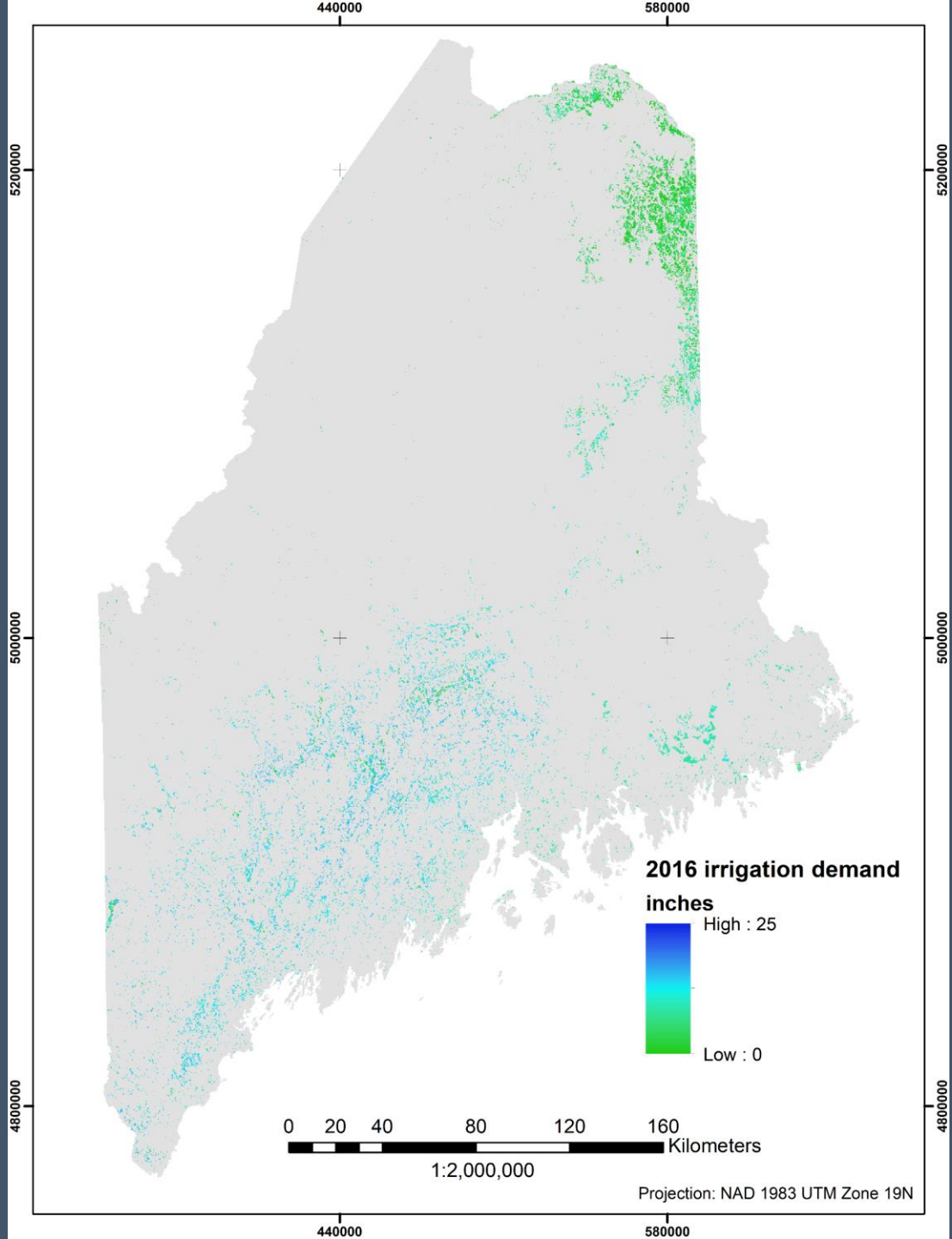
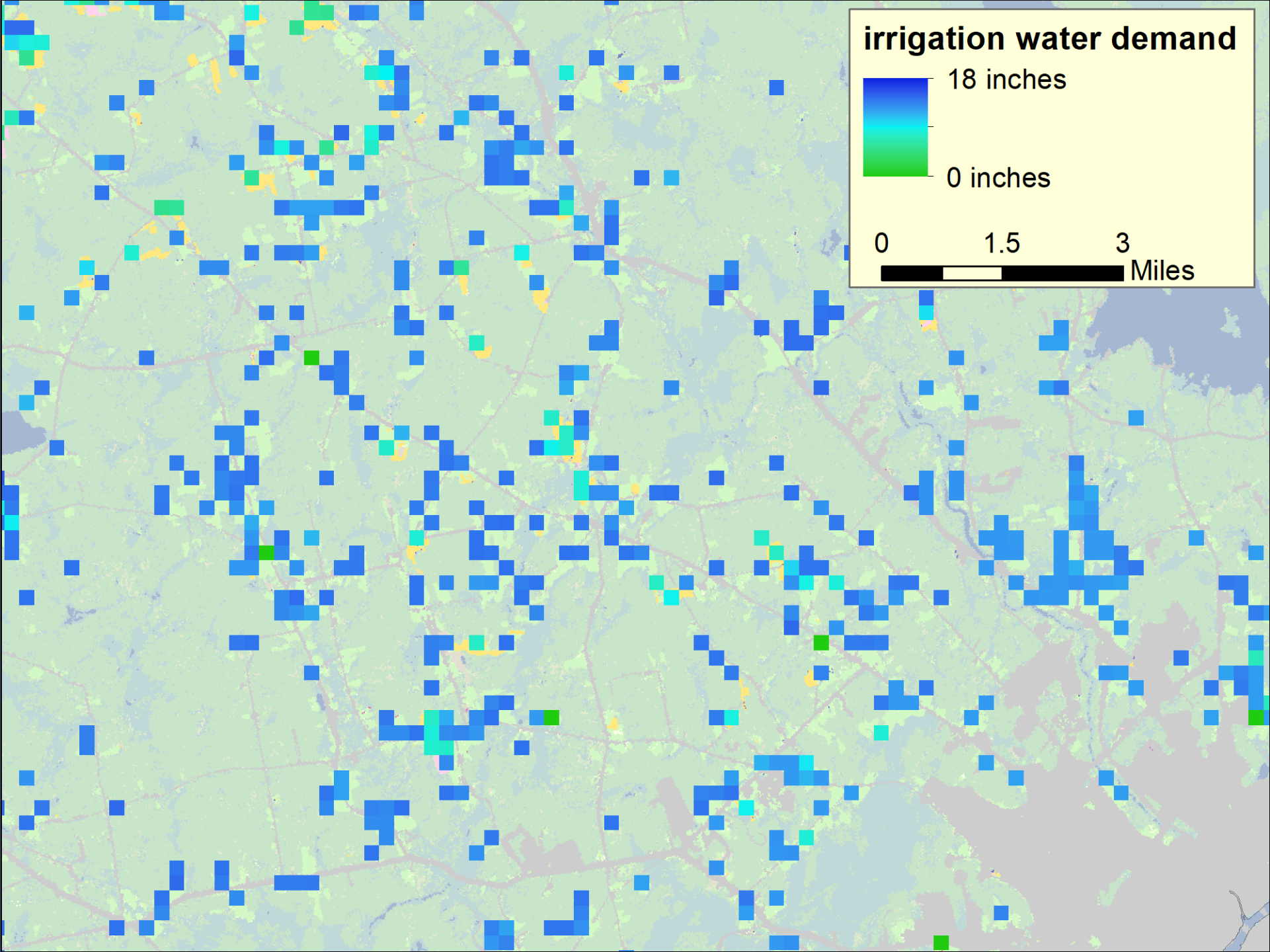# Survey results
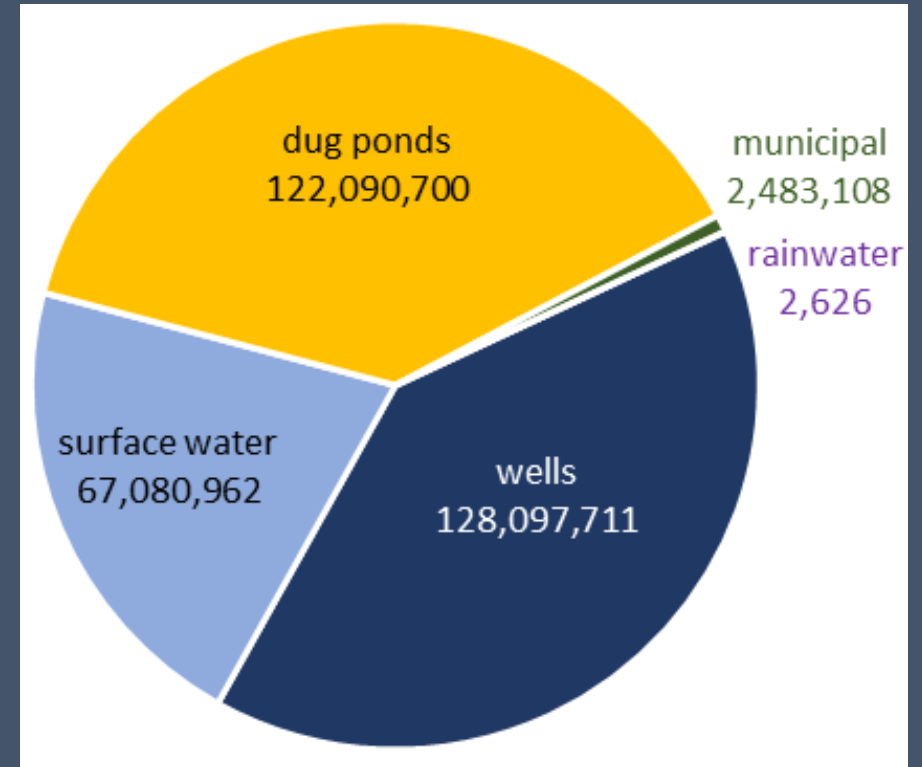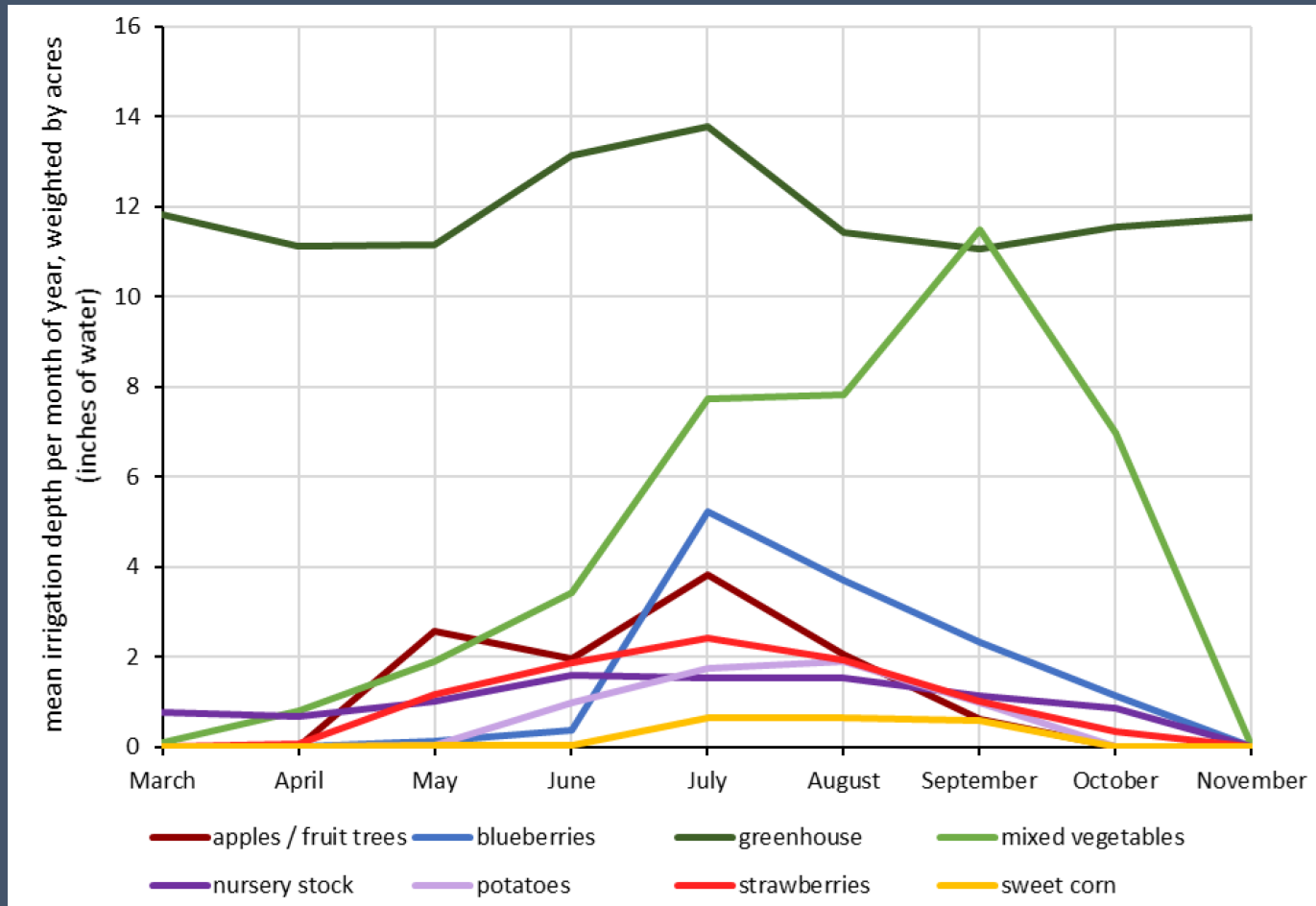
...and much more!

Ag Part 2: Irrigation Demand Model

- Employs a gridded, climate-based computer model of the soil water balance

- Calibrated to both USDA Census of Agriculture (2013) and results of our ag survey (2016)

- Output consists of <u>potential annual irrigation demand</u> in inches

- Multiply the demand by the actual irrigated land area

USGS Soil Water Balance (SWB) Model

- A climate-based, soil water balance model performed on a daily timestep
- Gridded calculations in crop areas defined by the USDA Cropland Data Layer
- Calculates precipitation, snowmelt, direct runoff, evapotranspiration, soil moisture storage, and infiltration beyond root zone
- Additional module implementing the FAO-56 crop evapotranspiration method (Allen et al., 1998)
- Difference between natural soil moisture and maximum allowable depletion (defined by crop) is called the "irrigation demand"
- Output is a 250-m grid of annual <u>irrigation demand</u> in inches

2016 irrigation demand

inches
High : 25

Low : 0

0 20 40   80   120   160
                                    Kilometers
1:2,000,000

Projection: NAD 1983 UTM Zone 19N

2017 irrigation demand

inches
High : 25

Low : 0

0 20 40   80   120   160
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Projection: NAD 1983 UTM Zone 19N

Irrigation water use estimates (Statewide)

Table A3. Statewide irrigation water application volume estimated in years 2013, 2016, and 2017, by crop type and in total. The estimated irrigated area of each crop in Maine is multiplied by the mean irrigation water demand depth from Table A1 to arrive at the total water volume for each crop.

crop	irrigated acres	2013 mean inches	2013 million gallons	2016 mean inches	2016 million gallons	2017 mean inches	2017 million gallons
alfalfa	1,261	0.0	0.4	1.8	62	1.5	50
apples	490	5.8	77	16.8	223	13.0	173
blueberries	28,095	7.0	5,324	8.3	6,351	8.1	6,189
broccoli	3,600	3.8	374	3.6	351	5.2	504
Christmas trees	298	0.2	2	1.3	10	1.6	13
corn	1,023	1.4	39	2.9	81	2.6	72
cranberries	30	14.0	11		0		0
grains	1,388	0.4	16	0.9	32	3.9	146
grass/pasture	0	2.4	0	4.9	0	5.2	0
hay non alfalfa	0	7.4	0	12.8	0	10.9	0
misc fruits and vegs	369	9.6	97	12.4	125	13.7	137
potatoes	9,438	4.7	1,206	5.3	1,355	7.8	2,008
sod/grass seed	562	7.1	108	11.3	172	9.5	145
soybeans	0	3.4	0	5.8	0	7.7	0
sweet corn	451	1.0	12	3.9	48		0
TOTAL	**47,005**		**7,266**		**8,810**		**9,436**

Domestic and public supply water use

2019-2020 WUDR project – Final report is being drafted now

Domestic and Public Supply Project

1. Improved programmatic method for compiling and analyzing data from public water utilities (collaboration with the Maine PUC).

2. Analyze patterns of use in billing data donated by a few water companies – develop per capita coefficients for domestic use.

3. Population estimates for public water systems and self-supplied homes using utility network maps and population data.
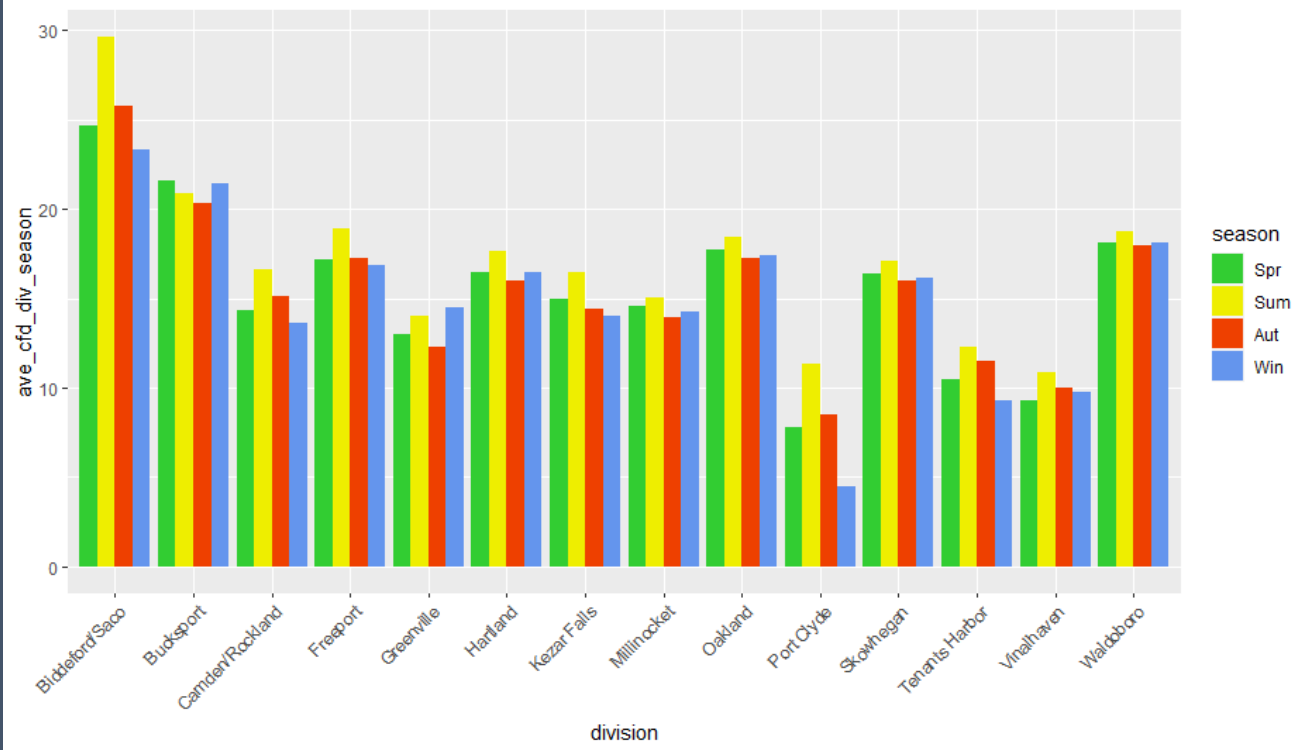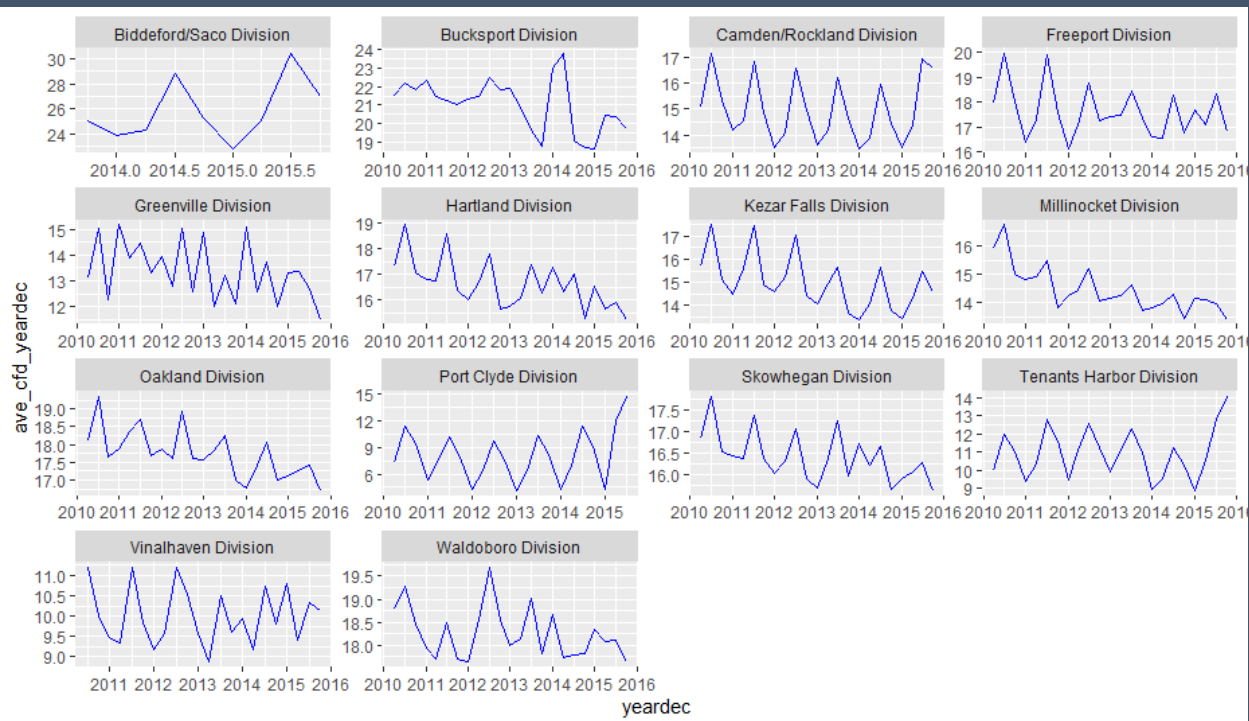
Public Water Systems

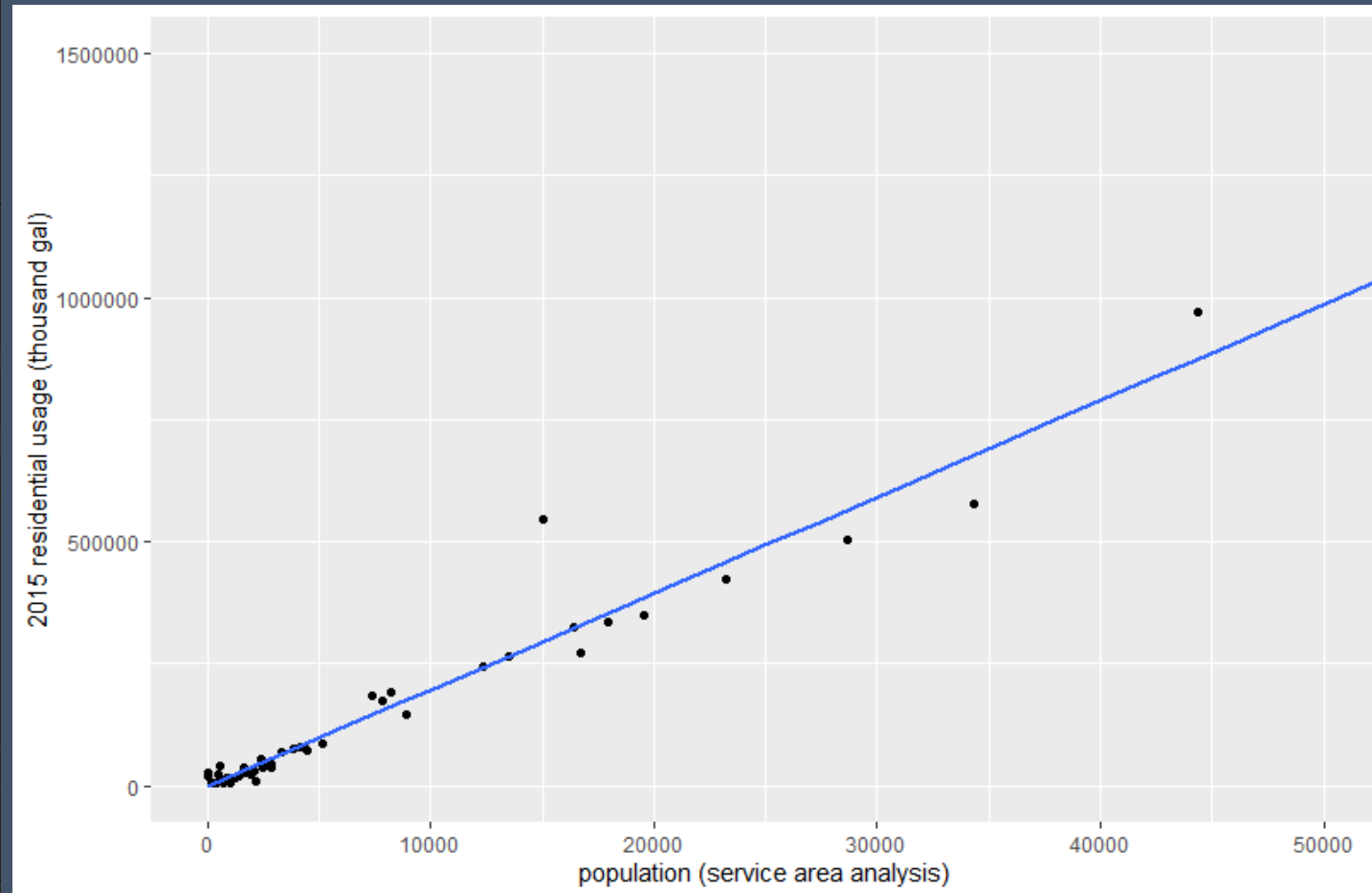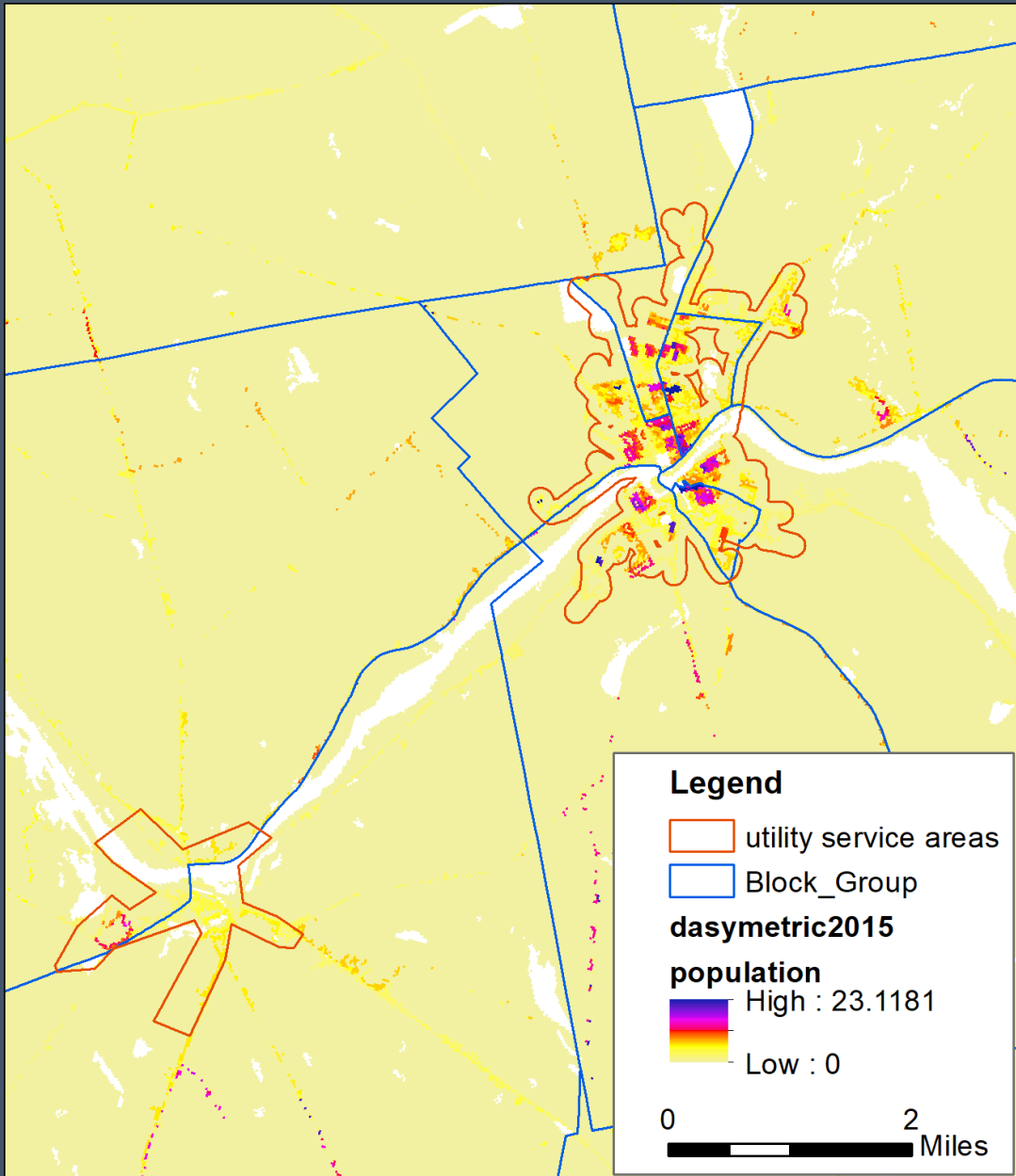Data collected for Public Utilities (1/3 of all community systems):

- Annual withdrawals
- Deliveries to residential customers
- System losses

⊕ Public Water Systems
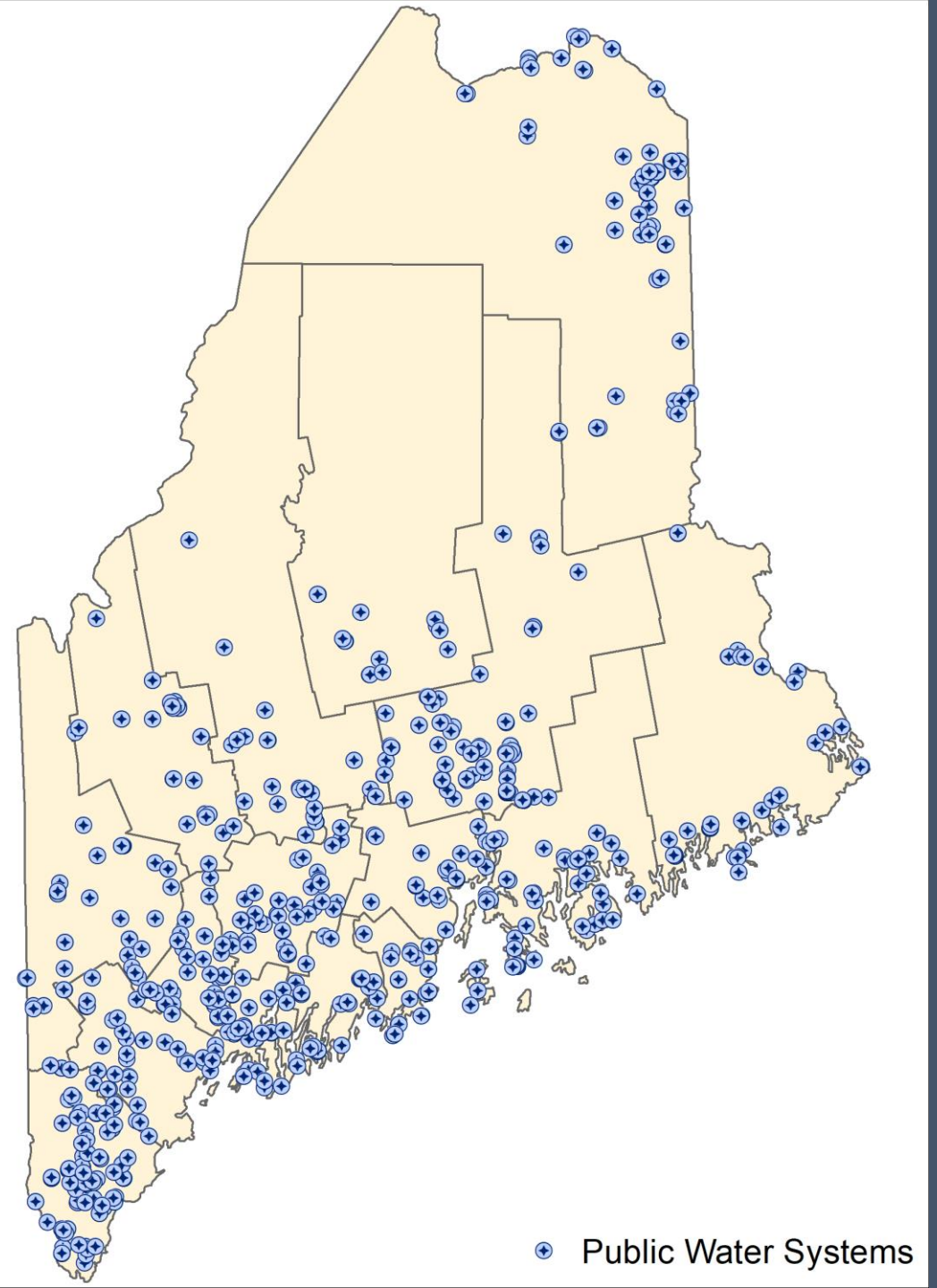
Meter data from 14 districts

Population estimates
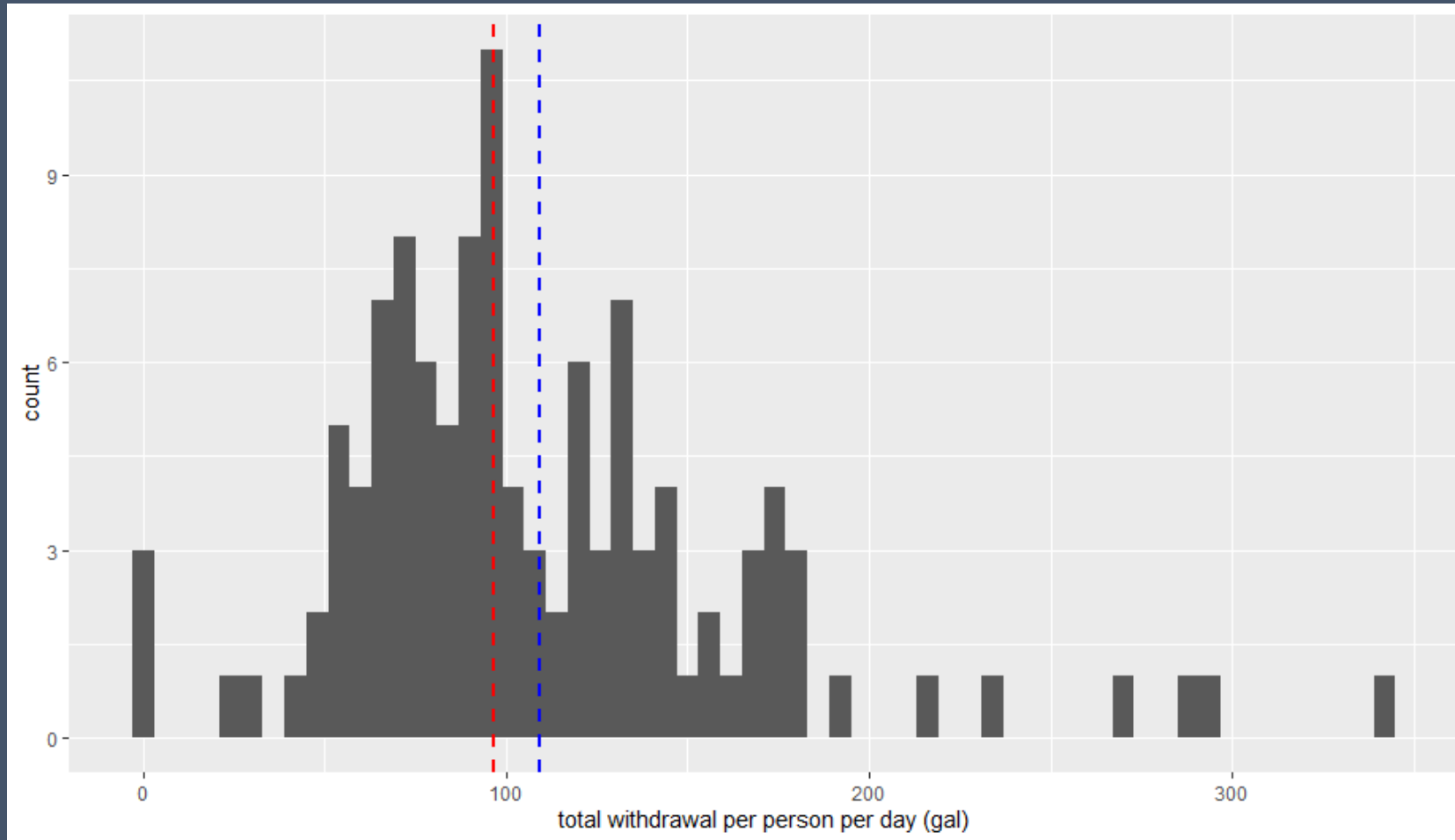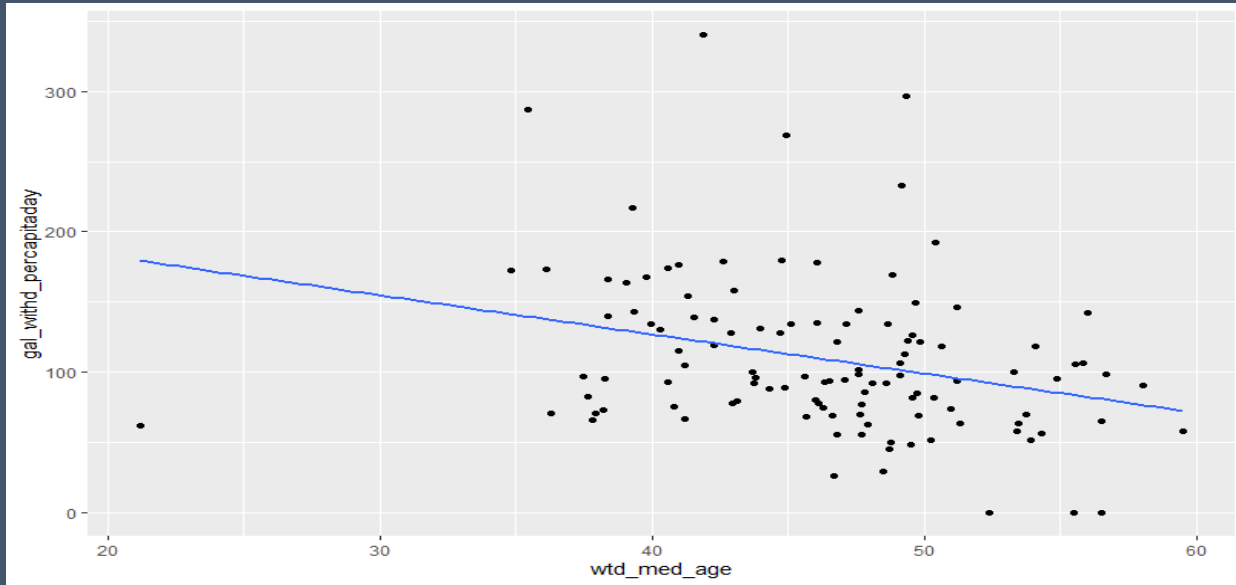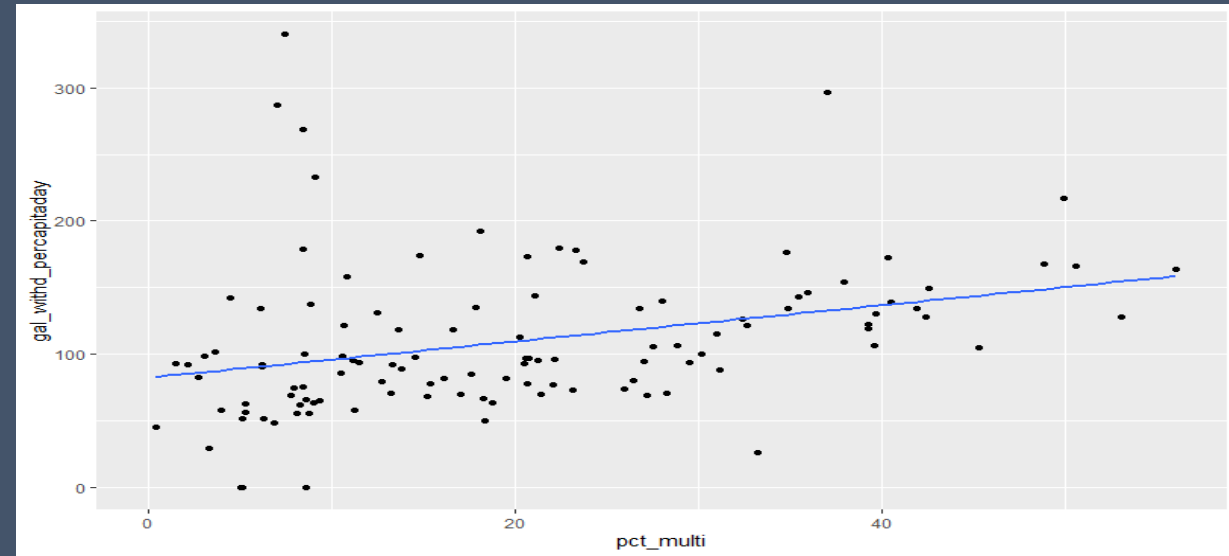
Per-capita water use

Figure 2. Total utility water withdrawal per capita for 115 districts. Median (red) is 96.6 gal/day, mean (blue) is 109 gal/day.

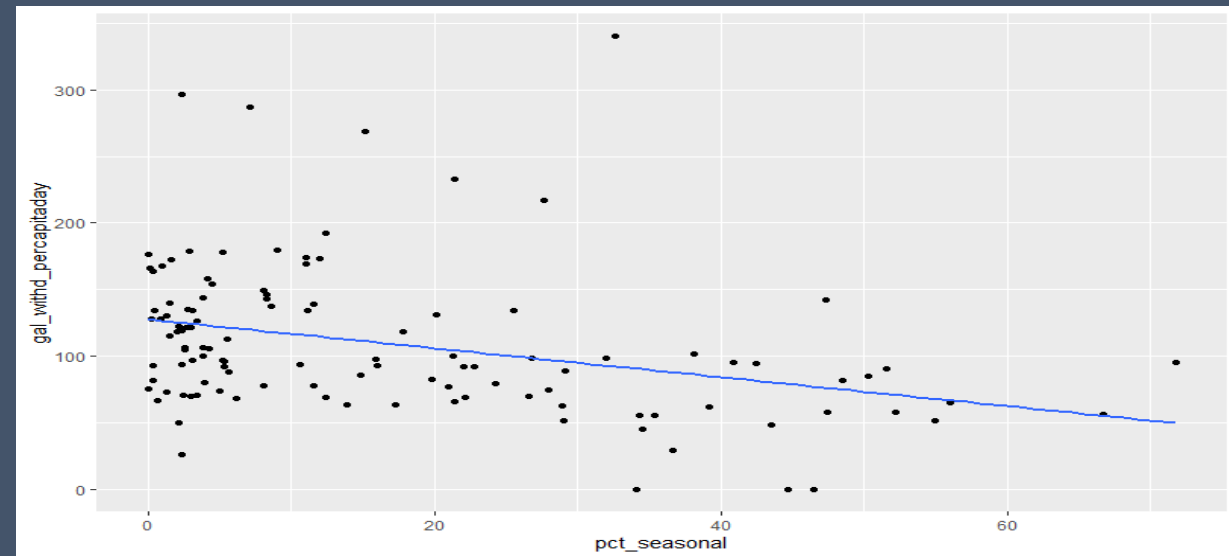# Household use varies with demographics

Percent multi-unit housing

Median age

Percent seasonal housing

Total water use estimates (by political division)

county	total population (2018)	public water utilities			self-supplied households	
		population served by public water	total annual withdrawal (gallons)	residential usage (gallons)	self-supplied population	residential usage (gallons)
Androscoggin	107,914	66,946	2,937,058	1,189,881	40,968	1,995,484
Aroostook	67,318	28,823	1,503,634	471,876	38,495	1,875,032
Cumberland	293,673	204,492	9,306,852	4,025,359	89,181	4,343,877
Franklin	29,915	15,445	502,106	227,928	14,470	704,812
Hancock	54,734	12,464	872,052	255,276	42,270	2,058,897
Kennebec	122,044	55,618	2,335,372	993,556	66,426	3,235,503
Knox	39,717	19,748	1,114,709	312,177	19,969	972,638
Lincoln	34,399	8,688	321,195	152,631	25,711	1,252,354
Oxford	57,754	17,385	1,038,885	311,008	40,369	1,966,288
Penobscot	151,817	75,687	3,461,747	1,302,547	76,130	3,708,177
Piscataquis	16,746	7,367	316,913	113,206	9,379	456,853
Sagadahoc	35,690	10,610	510,127	216,743	25,080	1,221,597
Somerset	50,489	16,415	675,246	295,056	34,074	1,659,682
Waldo	39,657	7,533	375,332	141,223	32,124	1,564,703
Washington	31,321	8,880	550,981	180,437	22,441	1,093,053
York	205,869	116,724	5,561,037	2,565,439	89,145	4,342,093
TOTAL	1,339,057	672,825	31,383,247	12,754,343	666,232	32,451,045

Industrial Use (2021-2022 WUDR project)

- Self-supplied industrial users (mills and other factories)
- Snowmaking
- Collaboration with the DEP to use wastewater data combined with voluntary surveys

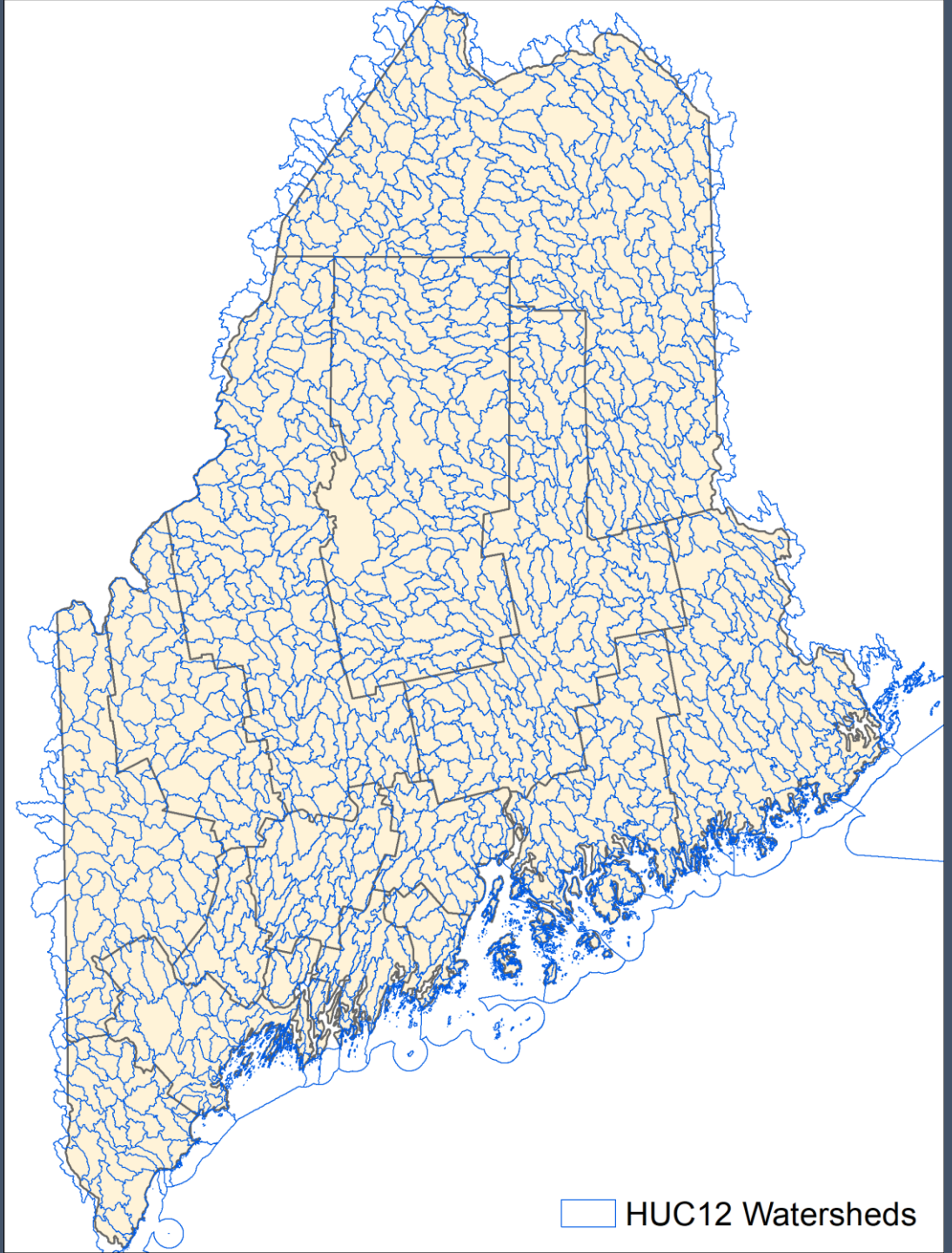- This project will complete our work for large category uses
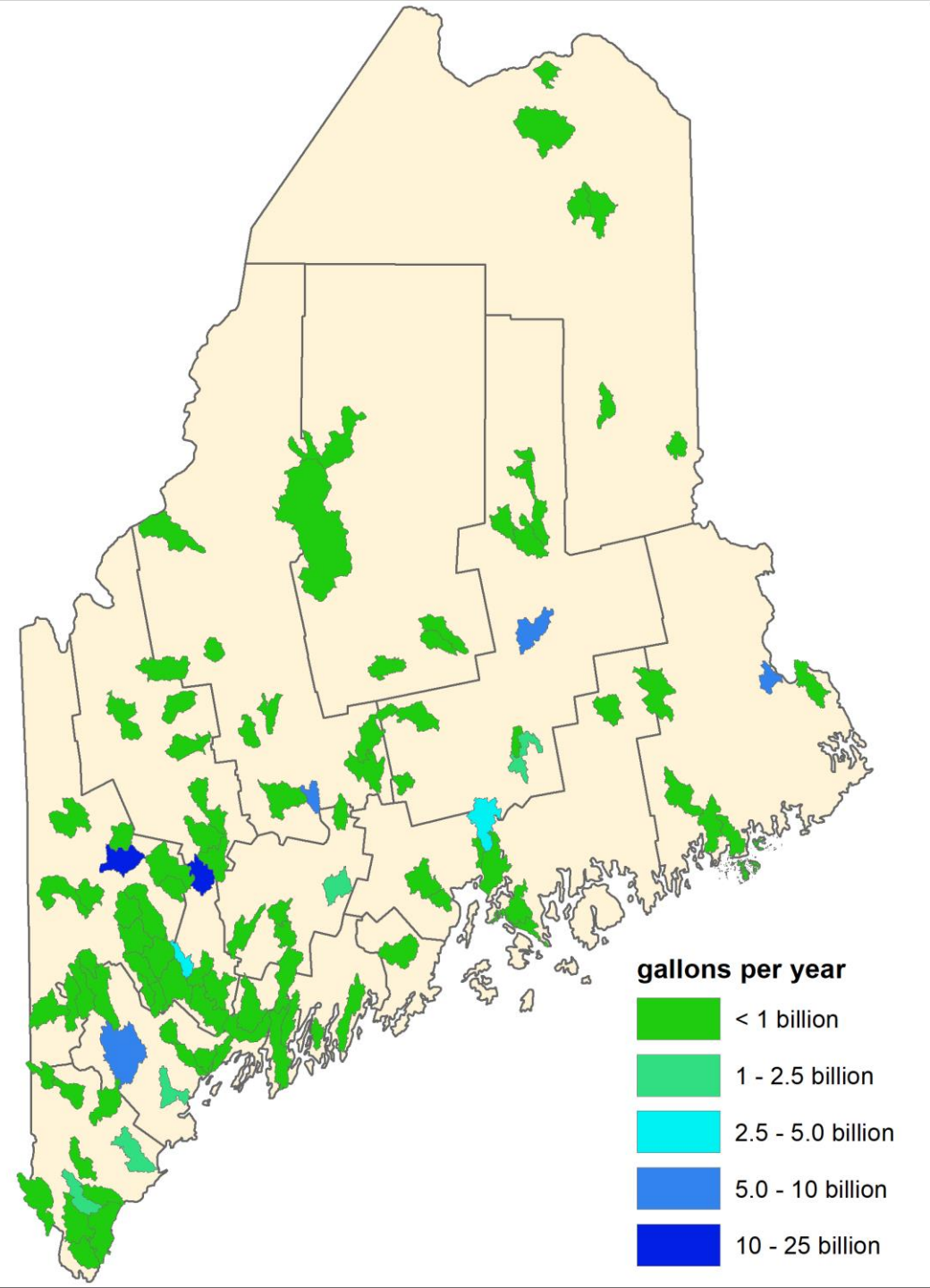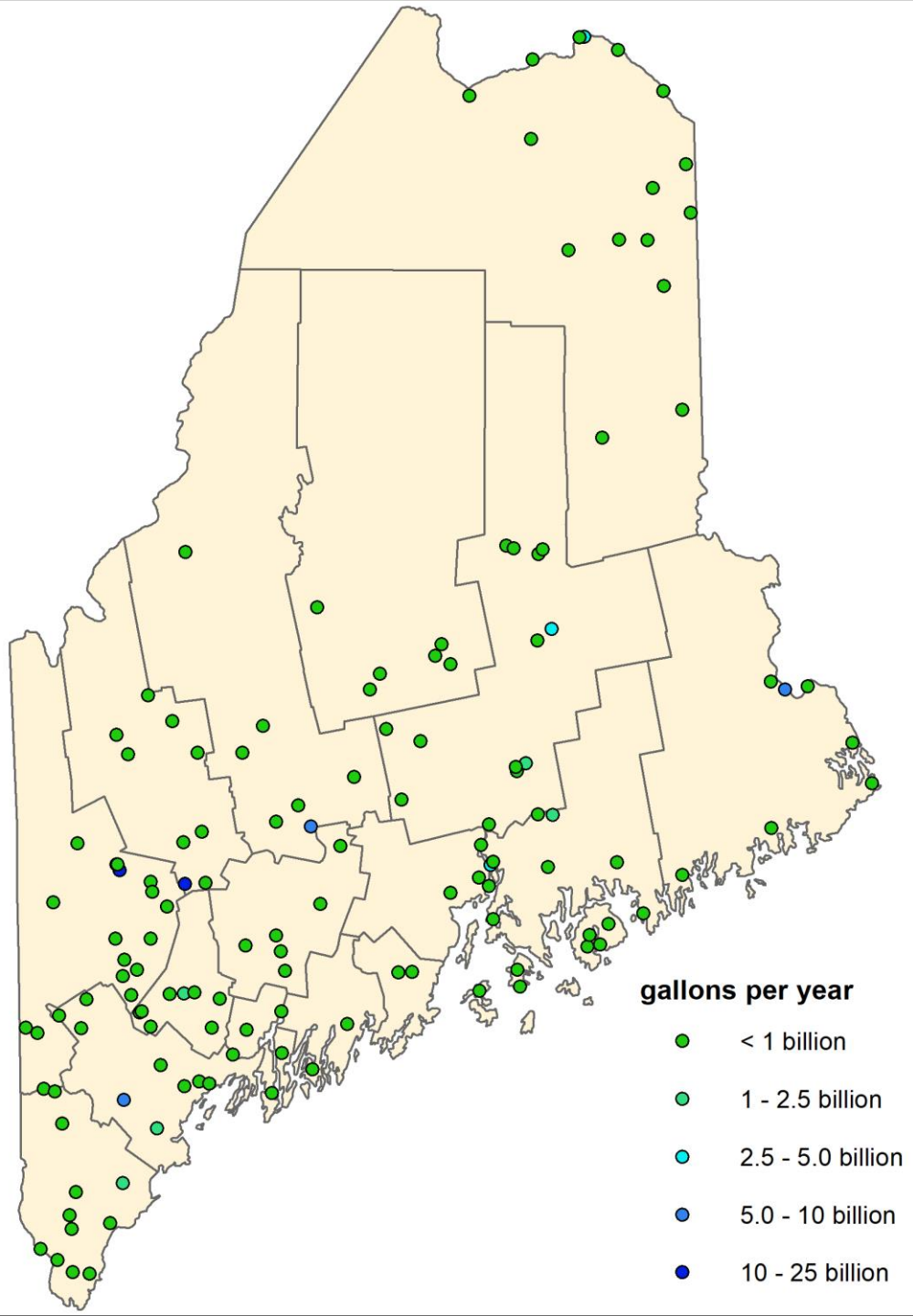
Watershed supply-and-demand analysis

A work in progress...

- Will look at the balance between water supply (annual runoff) and demand (<u>human use</u> and minimum stream flows)

- A revision and update to the "watersheds-at-risk" analysis from 2006

Watershed Analysis

- The analysis will cover all 12-digit HUC watersheds in Maine

- Water supply will be calculated by regression equations (USGS StreamStats)

- Minimum aquatic flows

- Human water consumption

HUC12 Watersheds

gallons per year
- < 1 billion
- 1 - 2.5 billion
- 2.5 - 5.0 billion
- 5.0 - 10 billion
- 10 - 25 billion

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- < 1 billion
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Any questions?

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Maine Geological Survey

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