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Silver Springs Restoration Plan

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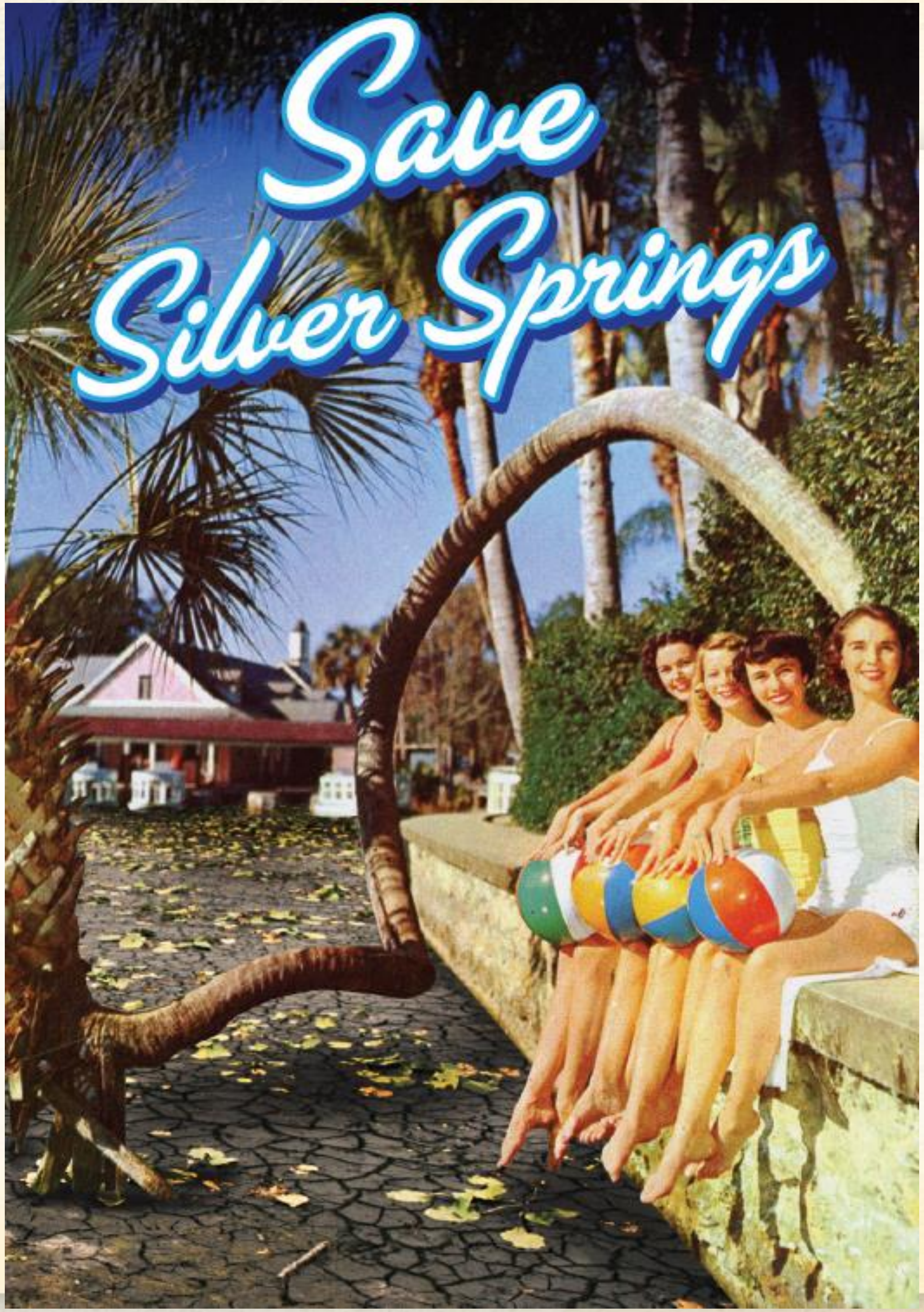
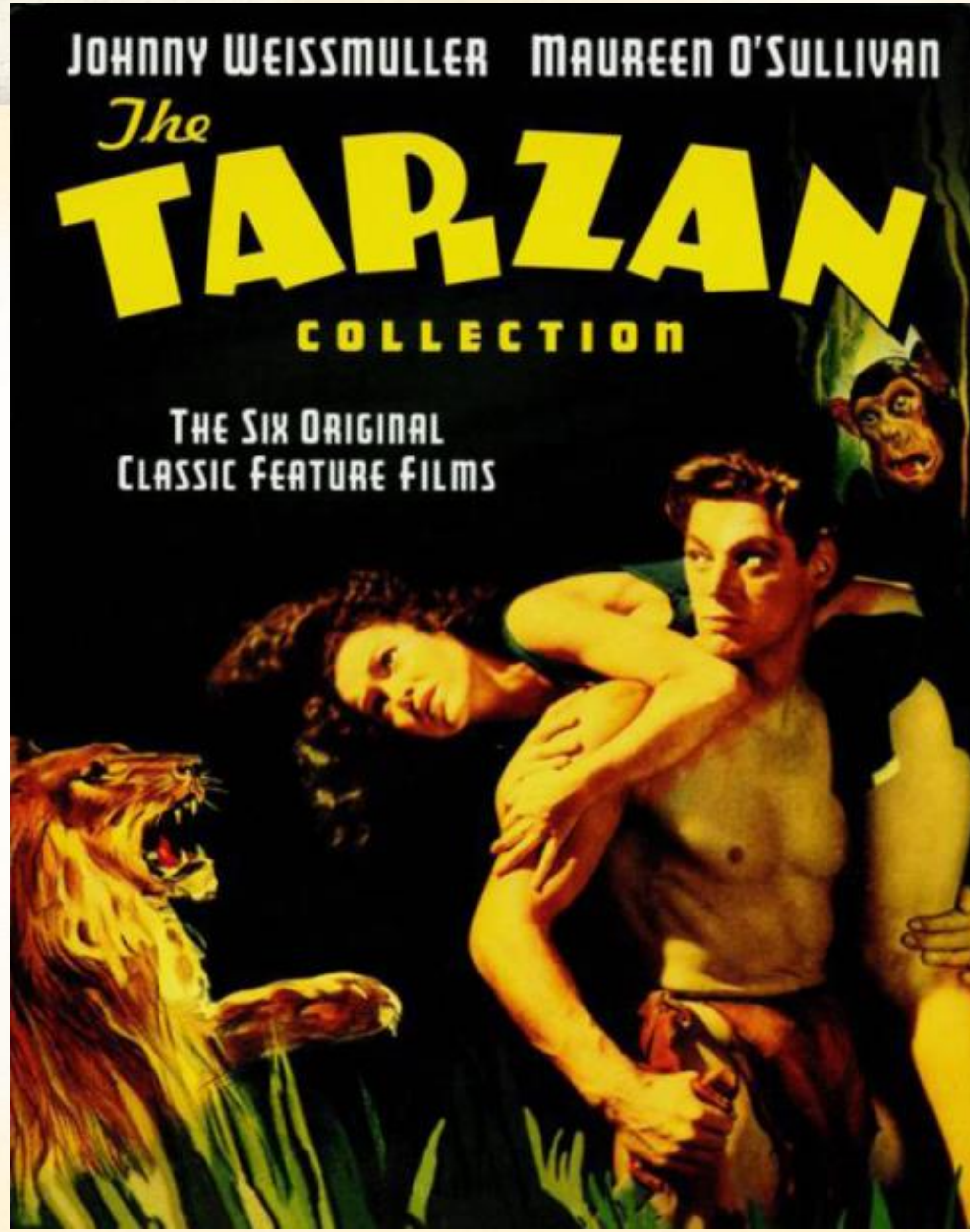
Howard T. Odum FLORIDA SPRINGS INSTITUTE



Project Sponsors

Wildlife Foundation of Florida Protect Springs License Tag Grant and the Felburn Foundation



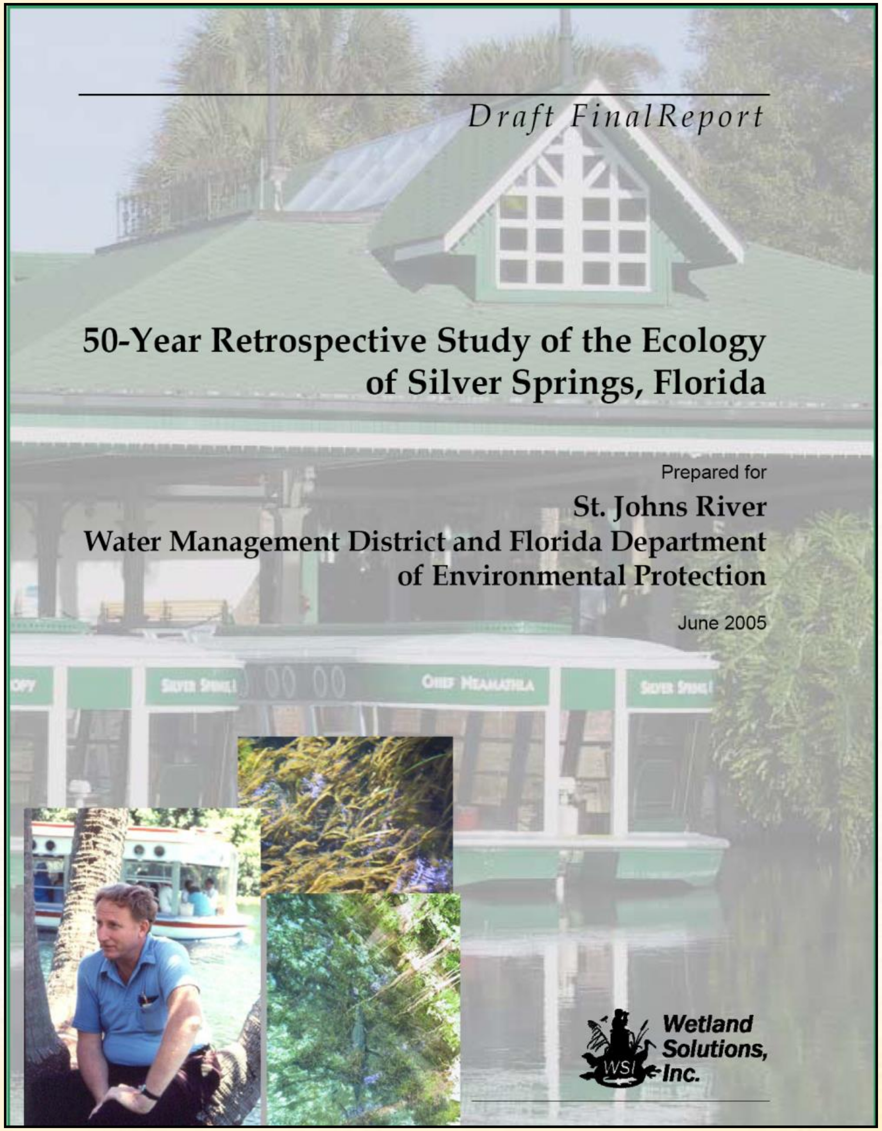
Silver Springs Background

Why is Silver Springs Important?

- Highest long-term flow recorded in any spring in the U.S.
- Headwaters of the Silver River and critical baseflow in the Ocklawaha and St. Johns Rivers
- Oldest tourist attraction in Florida
- Most comprehensively studied spring ecosystem in Florida

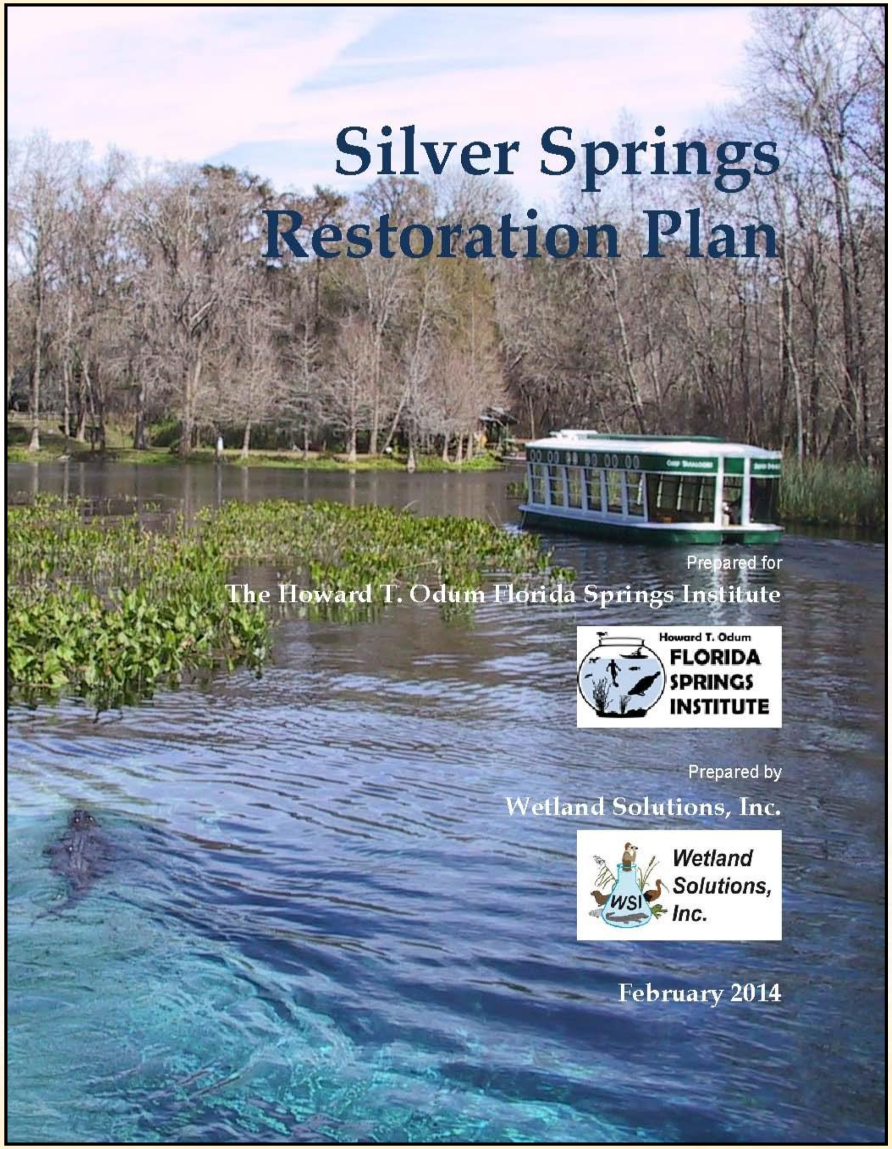
Silver Springs Research

- Howard T. Odum (1950s)
- Robert L. Knight (1970s)
- Silver Springs Working Group
- Florida Springs Task Force
- Florida Springs Initiative
- St. Johns River Water Management District
- University of Florida
- Silver Springs Alliance
- Wetland Solutions, Inc.
- Florida Fish and Wildlife Conservation Commission
- Florida Department of Environmental Protection



Silver Springs Restoration Plan

1. Detailed description of Silver Springs and Silver River System
2. Contributing groundwater basin or springshed
3. Identify ongoing threats to Silver Springs ecology
4. Roadmap for comprehensive restoration of Silver Springs

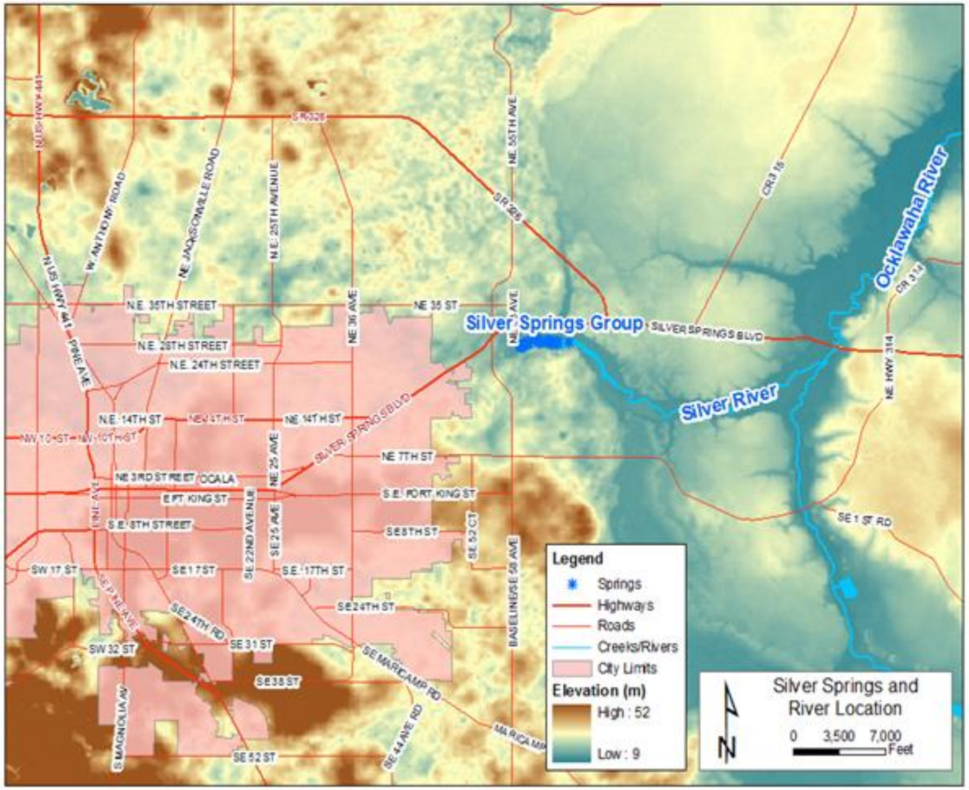


Key Silver Springs Restoration Issues

1. Reduced spring flows due to consumptive uses
2. Elevated groundwater nitrate due to high fertilizer loads, and wastewater management practices
3. Physical barriers to wildlife movement (Rodman Dam)

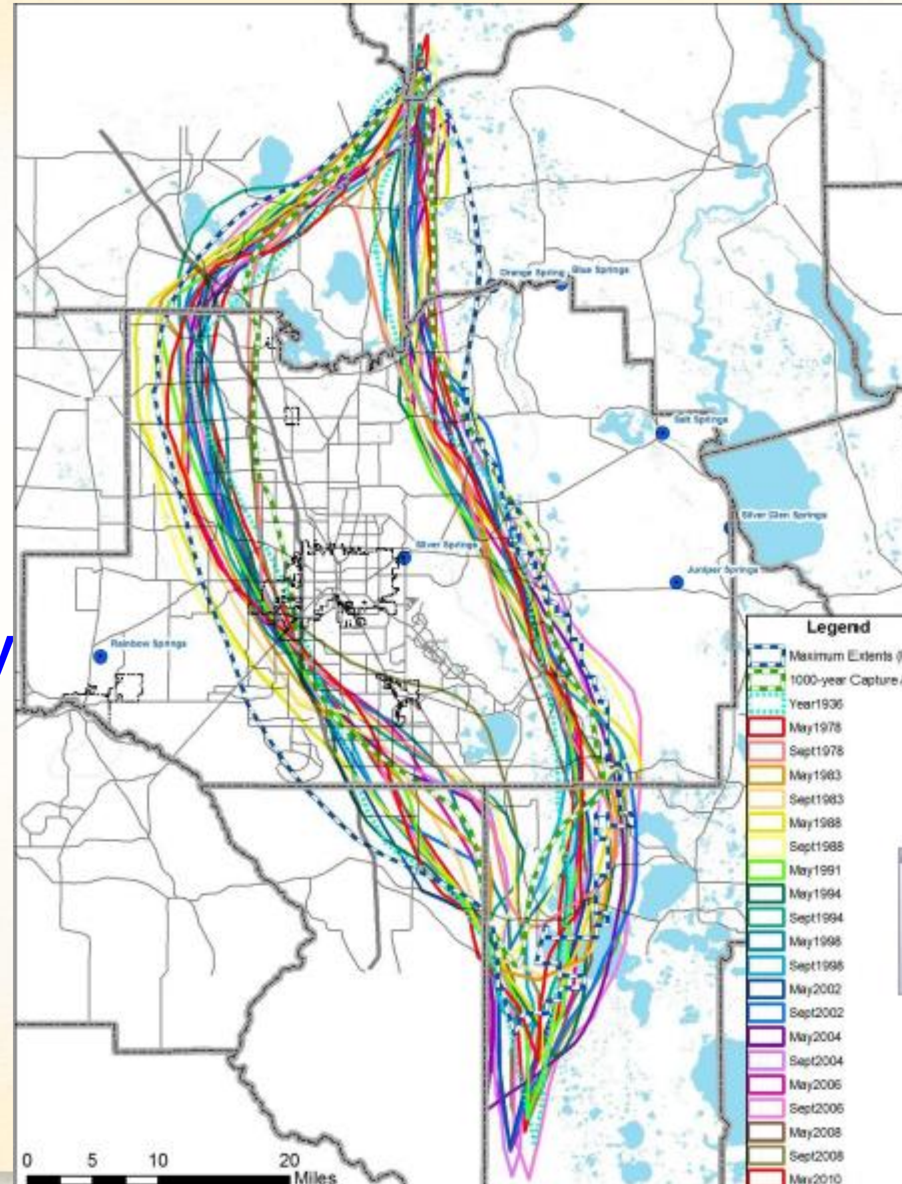
Silver Springs Location Map

- Located east of Ocala in Marion County
- Tributary to the Lower Ocklawaha River



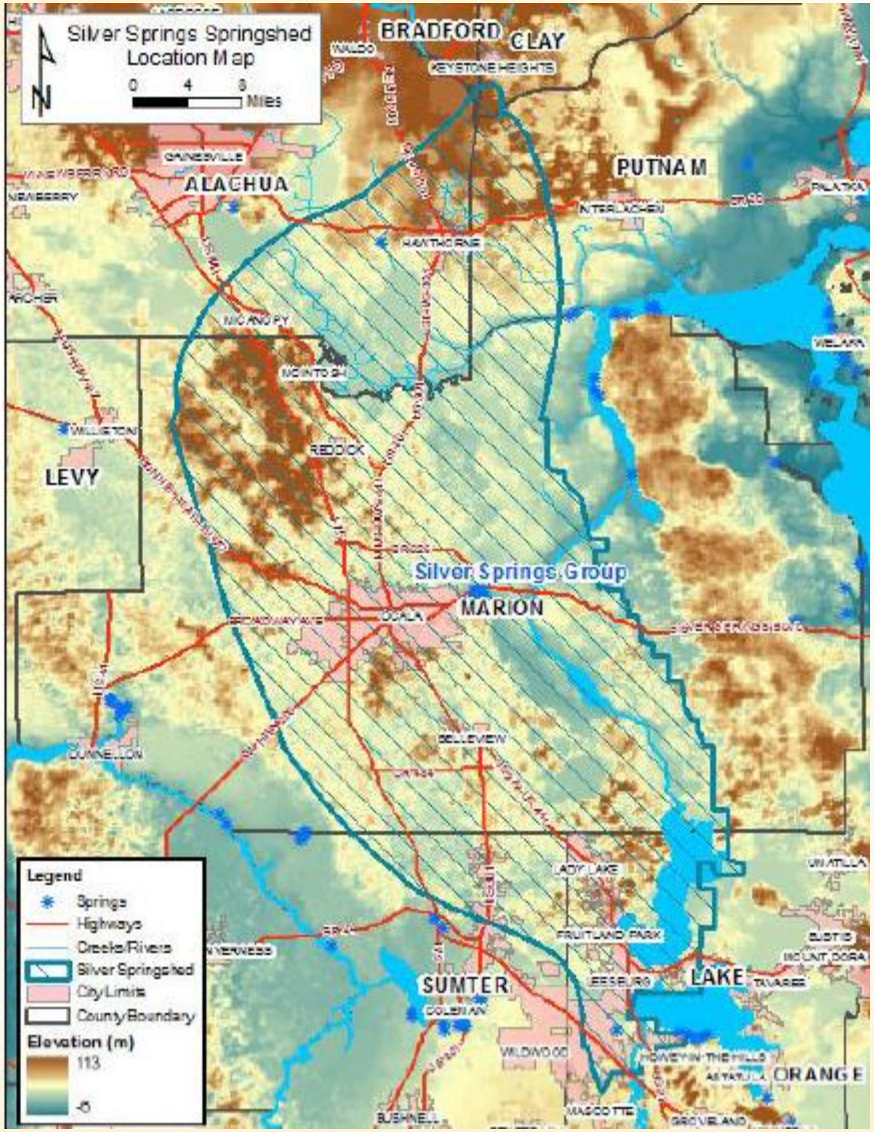
Silver Springs Springshed

- Estimated using
  - Potentiometric surface maps (Upper Floridan Aquifer)
  - Springsheds vary based on recharge and pumping



Silver Springs Springshed

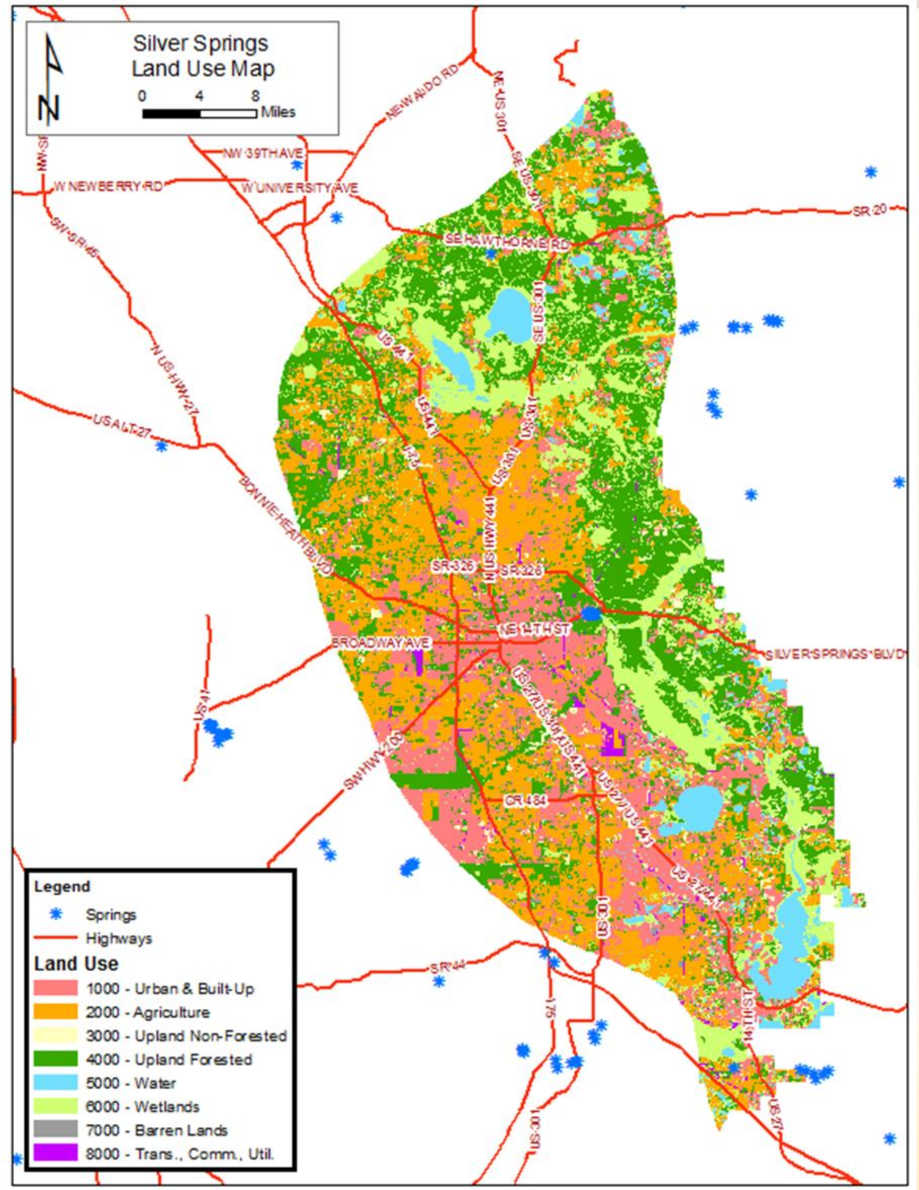
- Estimated "Maximum Extent" so that no pollutant loads are omitted
- Contributing area includes portions of Marion, Alachua, Putnam, Sumter, and Lake Counties
- 1,360 mi^2



Land Use / Land Cover

2005 Land Use

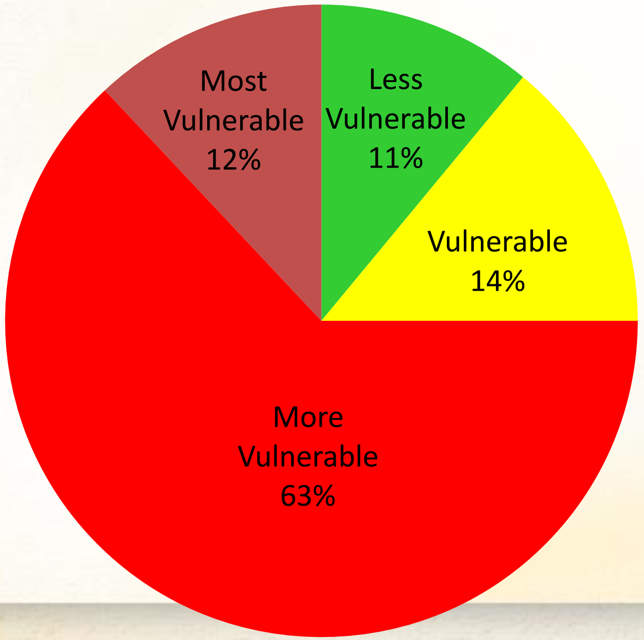
- Urban – 23%
- Agriculture/pasture – 28%
- Forested – 27%
- Wetlands – 16%

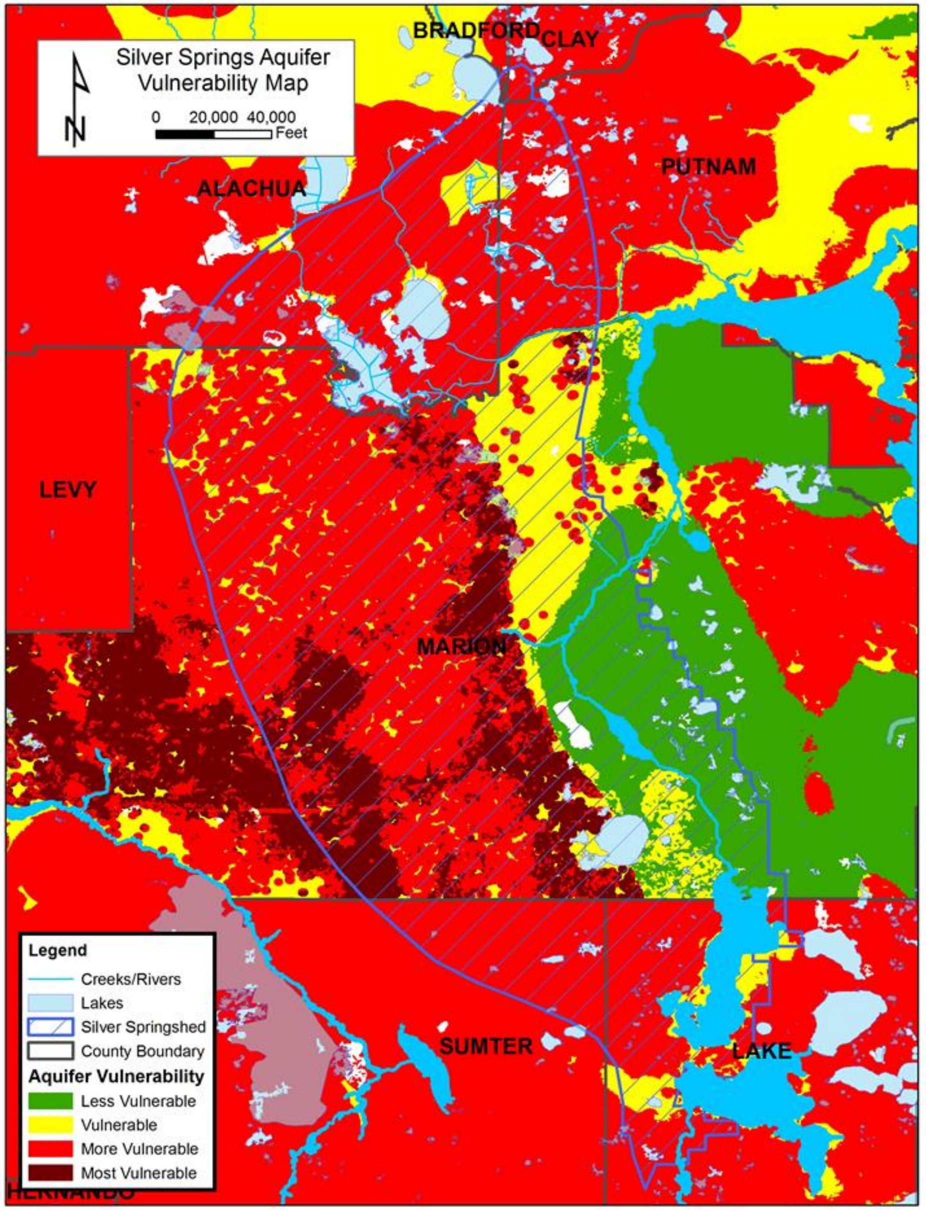


Aquifer Vulnerability

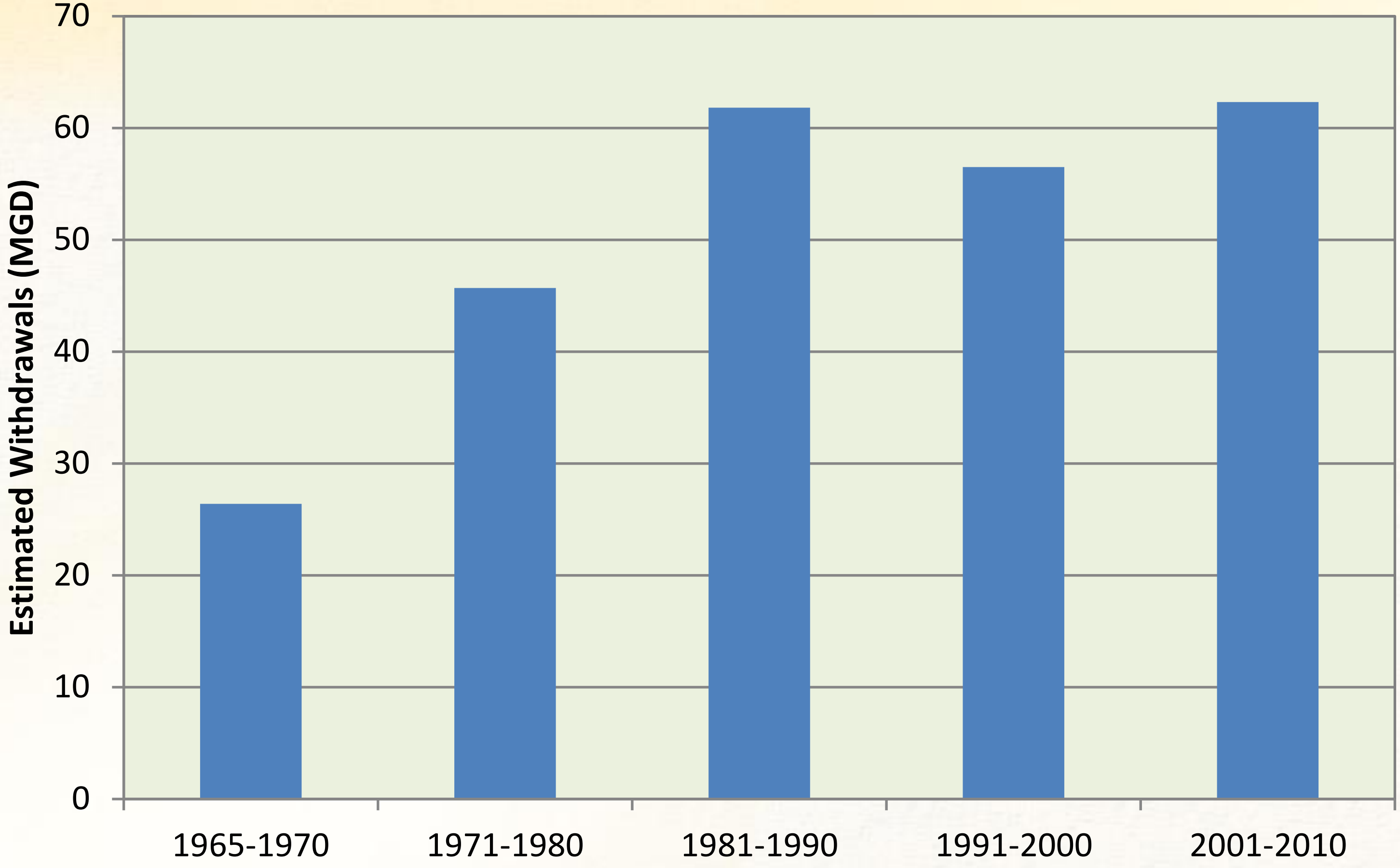
89% is vulnerable, to most vulnerable, estimated by:

- High recharge rates,
- Absence of confining layers, and
- depth to the surface of the underlying aquifer





Springshed Groundwater Withdrawals



Estimated groundwater withdrawals more than doubled between 1965 – 2010

Regional Groundwater Withdrawals

Agriculture

Residential

Golf Course

Estimated groundwater withdrawals in Marion, Alachua, Putnam, Sumter, Lakes, and Levy Counties increased from 197 to 471 MGD between 1965 – 2010

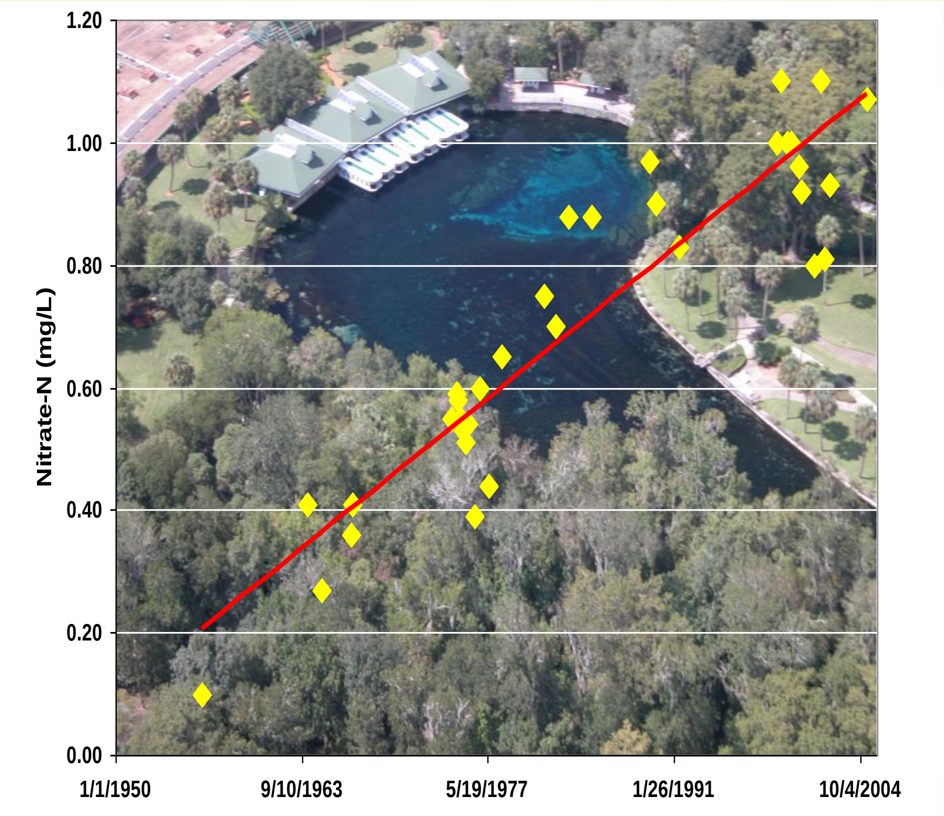
Springshed Nitrogen Loading

Annual springshed estimated nitrogen mass loading to the Floridan Aquifer was 2.9 million pounds per year between 2000 and 2010

Source	Mass (tons)	Percent
Inorganic fertilizer (agricultural and urban)	733	51
On-site wastewater disposal	343	24
Rainfall and recharge	218	15
Wastewater disposal	105	7
Stormwater inflow	43	3
Total	1442	100

Agricultural and urban fertilizer are likely largest contributors

Silver Springs Combined Nitrogen Load



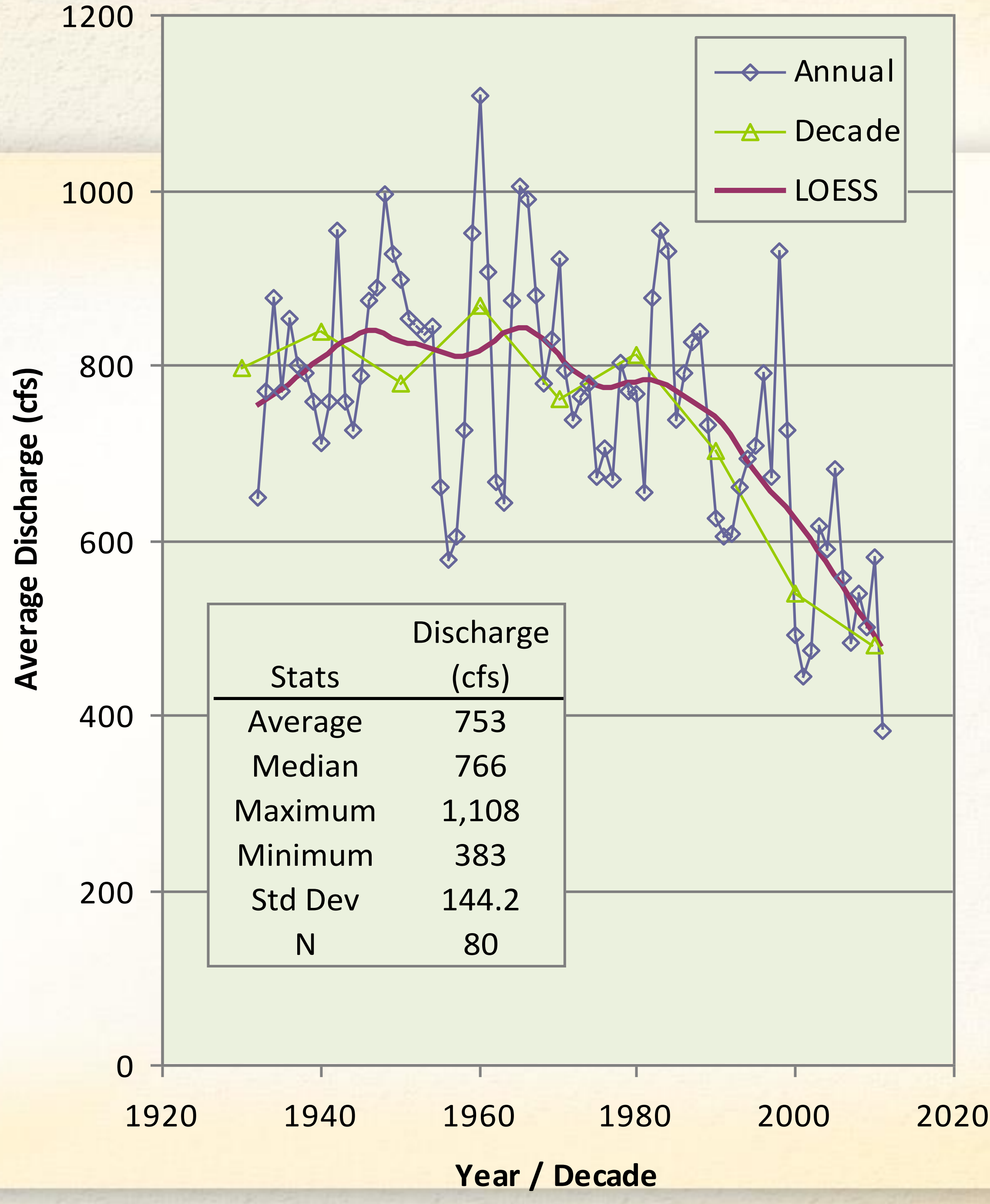
25-fold increase since 1907

(Munch *et al.* 2006)

Year	Nitrate-N Load (tons/yr)
1957	47
1979	407
1995	478
2005	529
2055 (projected)	880

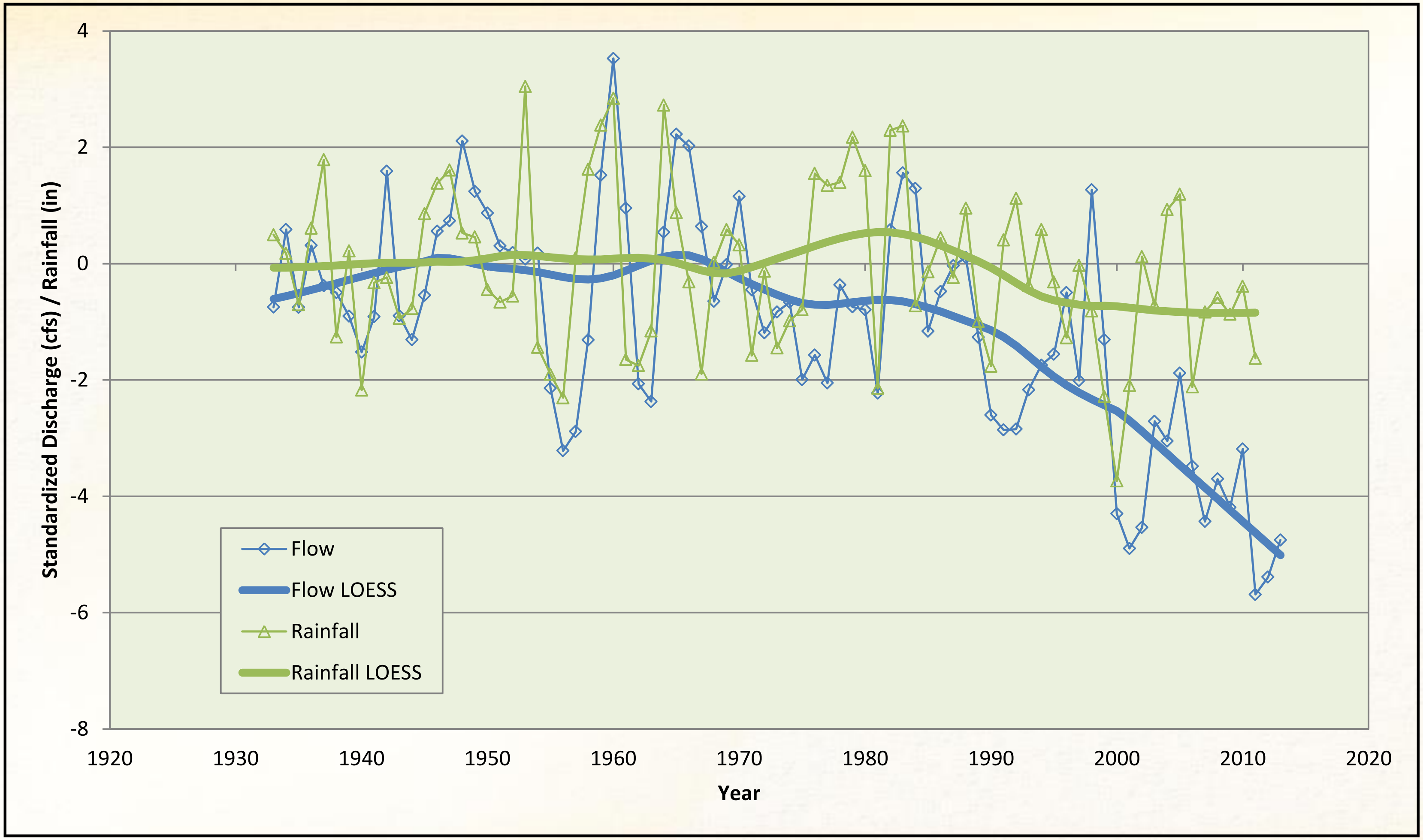
Silver Springs Discharge
(1932-2011)

Flow trend has been a steep decline starting in the 1980s. 2011/2012 flows were 50% of the long-term average flow.



Stats	Discharge (cfs)
Average	753
Median	766
Maximum	1,108
Minimum	383
Std Dev	144.2
N	80

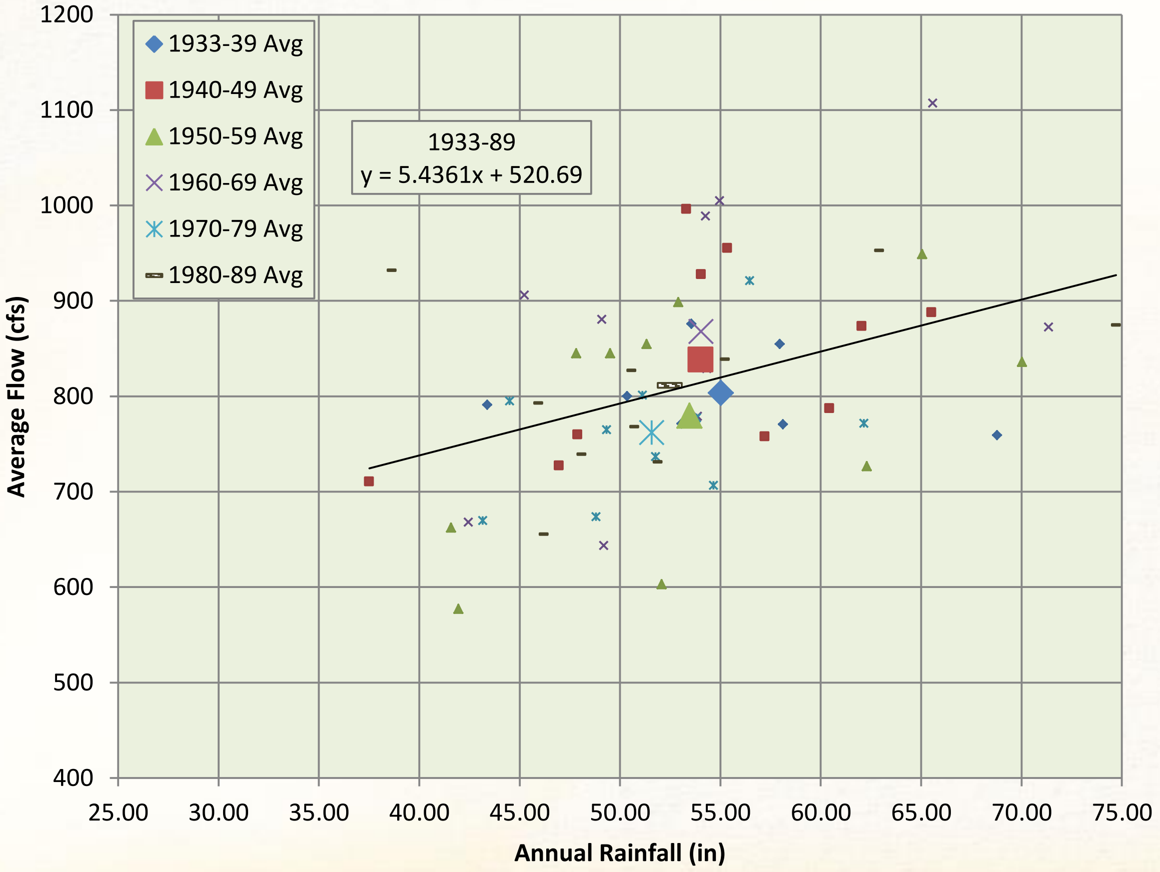
Silver Springs Rainfall and Flow



standardized using 1933-1952 data

Silver Springs Rainfall vs. Flow

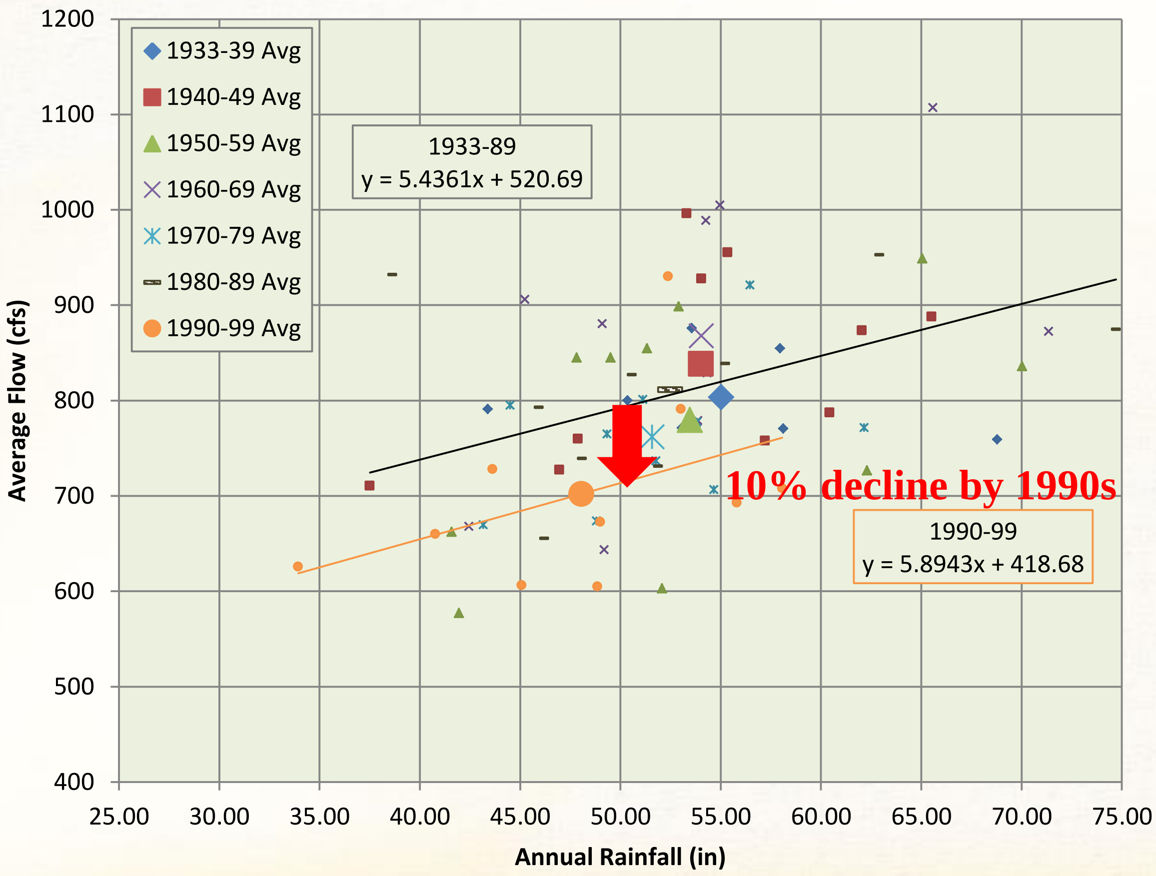
1933 – 1989: average = 800 cfs (515 MGD)



Based on an average rainfall total of 50 inches per year

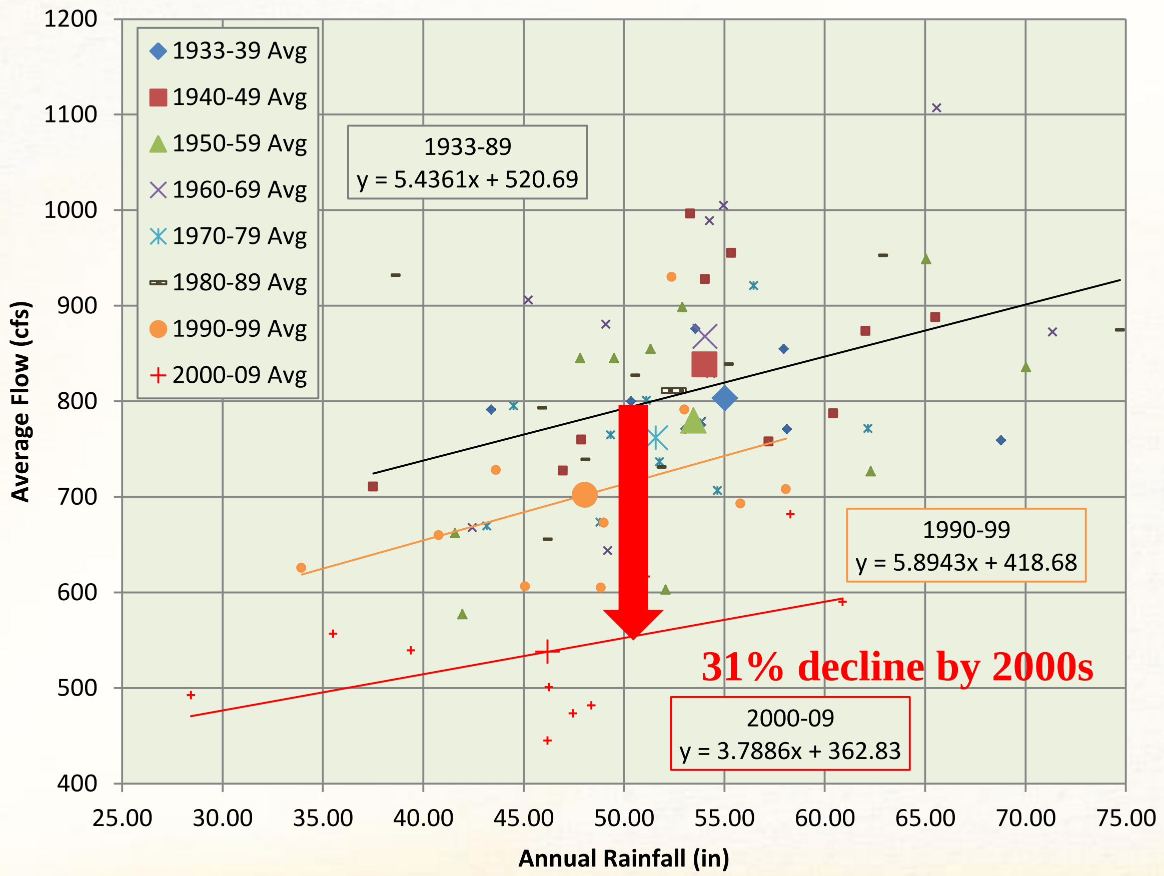
Silver Springs Rainfall vs. Flow

1990 – 1999: 80 cfs decline (10%)



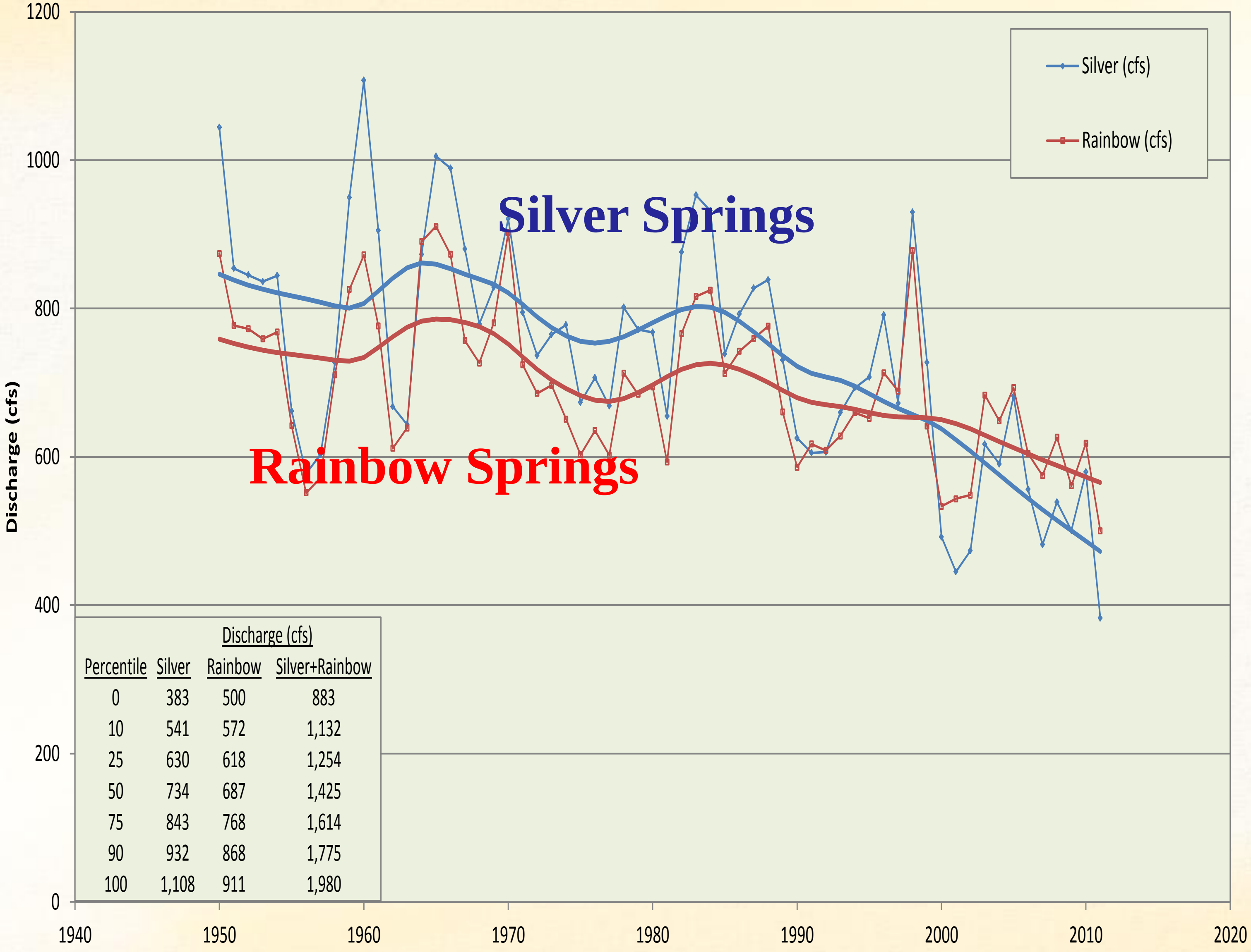
Silver Springs Rainfall vs. Flow

2000 – 2009: 250 cfs decline (31%)



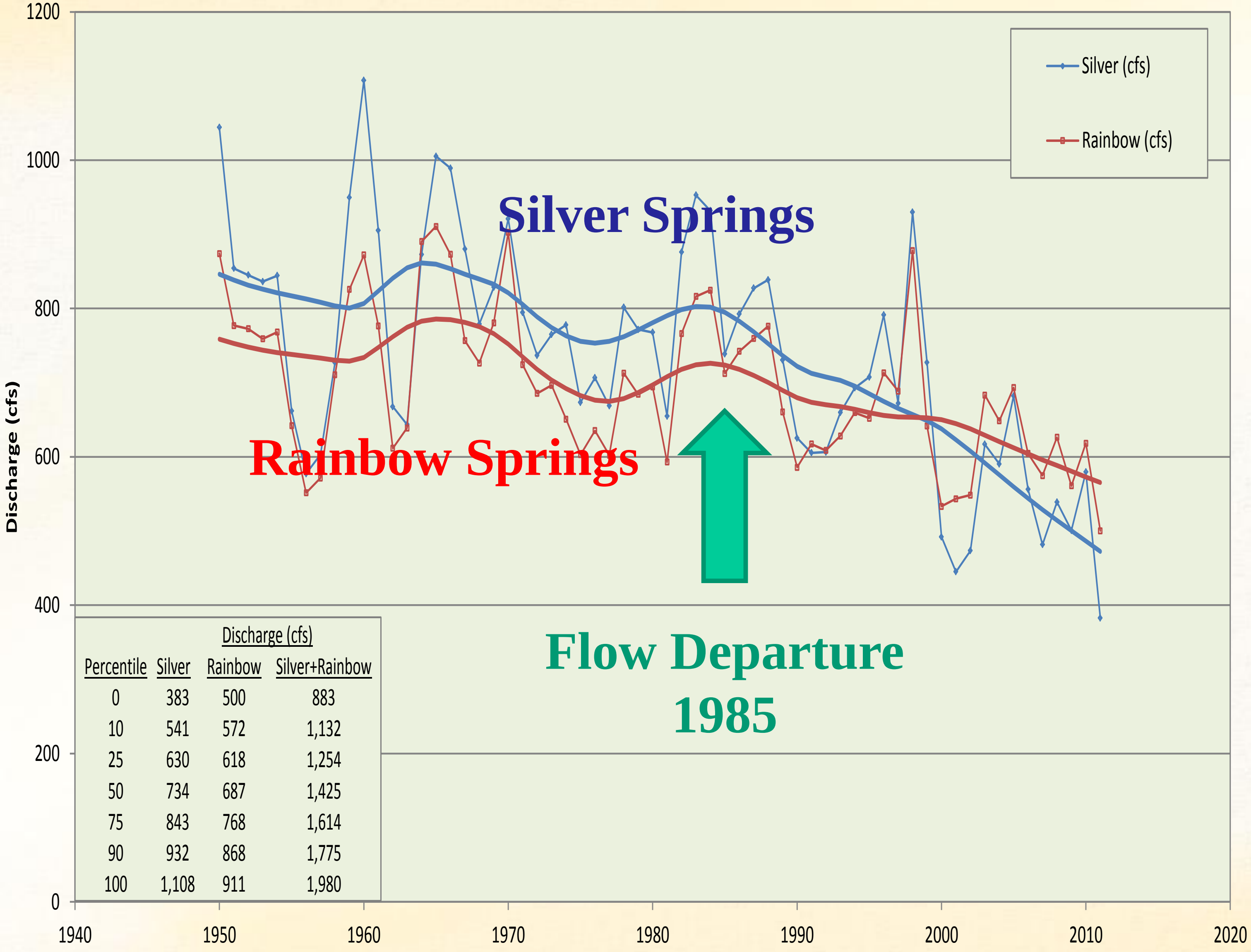
31% Flow Reduction is Independent of Rainfall Changes

Silver and Rainbow Flows

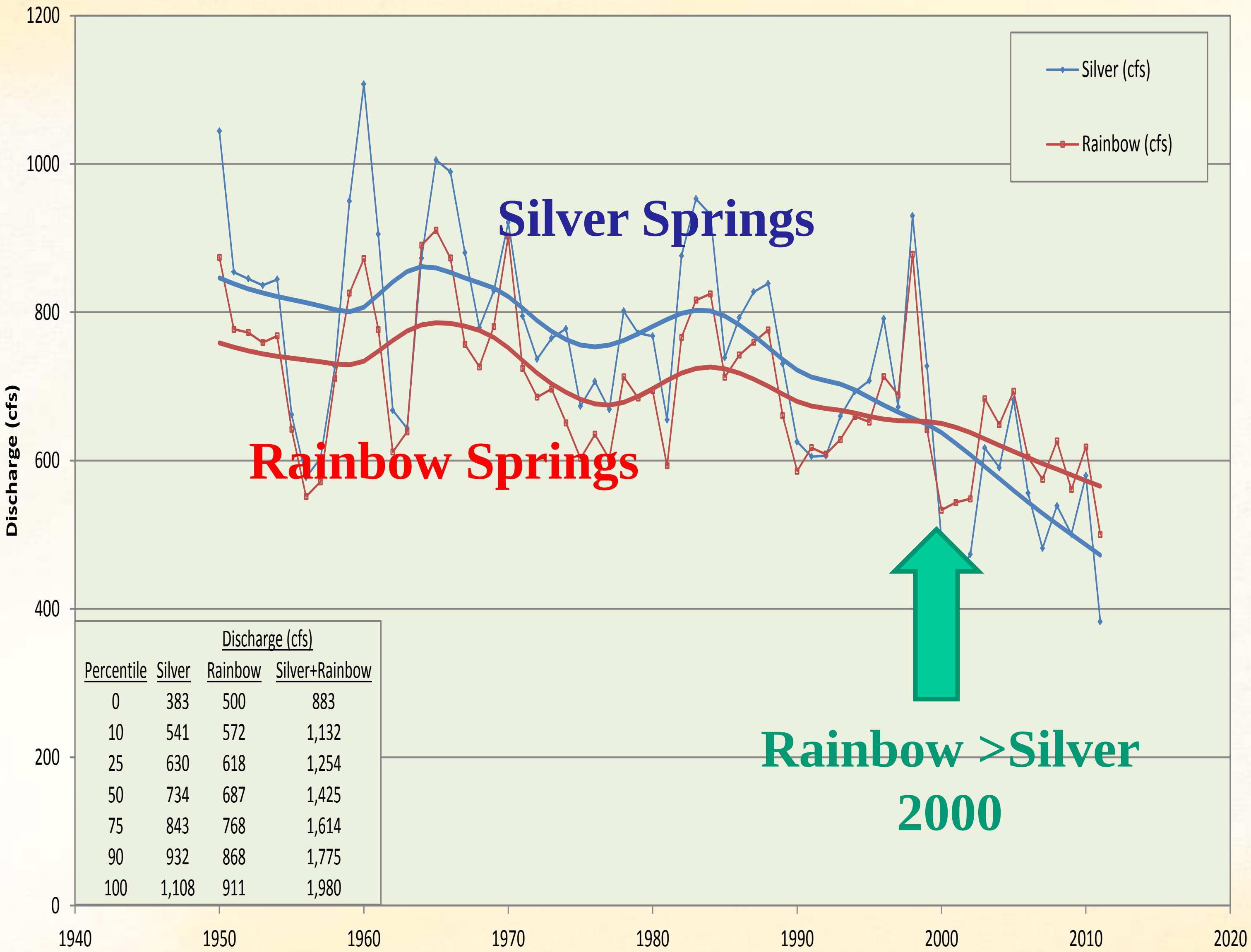


	Discharge (cfs)		
Percentile	Silver	Rainbow	Silver+Rainbow
0	383	500	883
10	541	572	1,132
25	630	618	1,254
50	734	687	1,425
75	843	768	1,614
90	932	868	1,775
100	1,108	911	1,980

Silver and Rainbow Flows



Silver and Rainbow Flows



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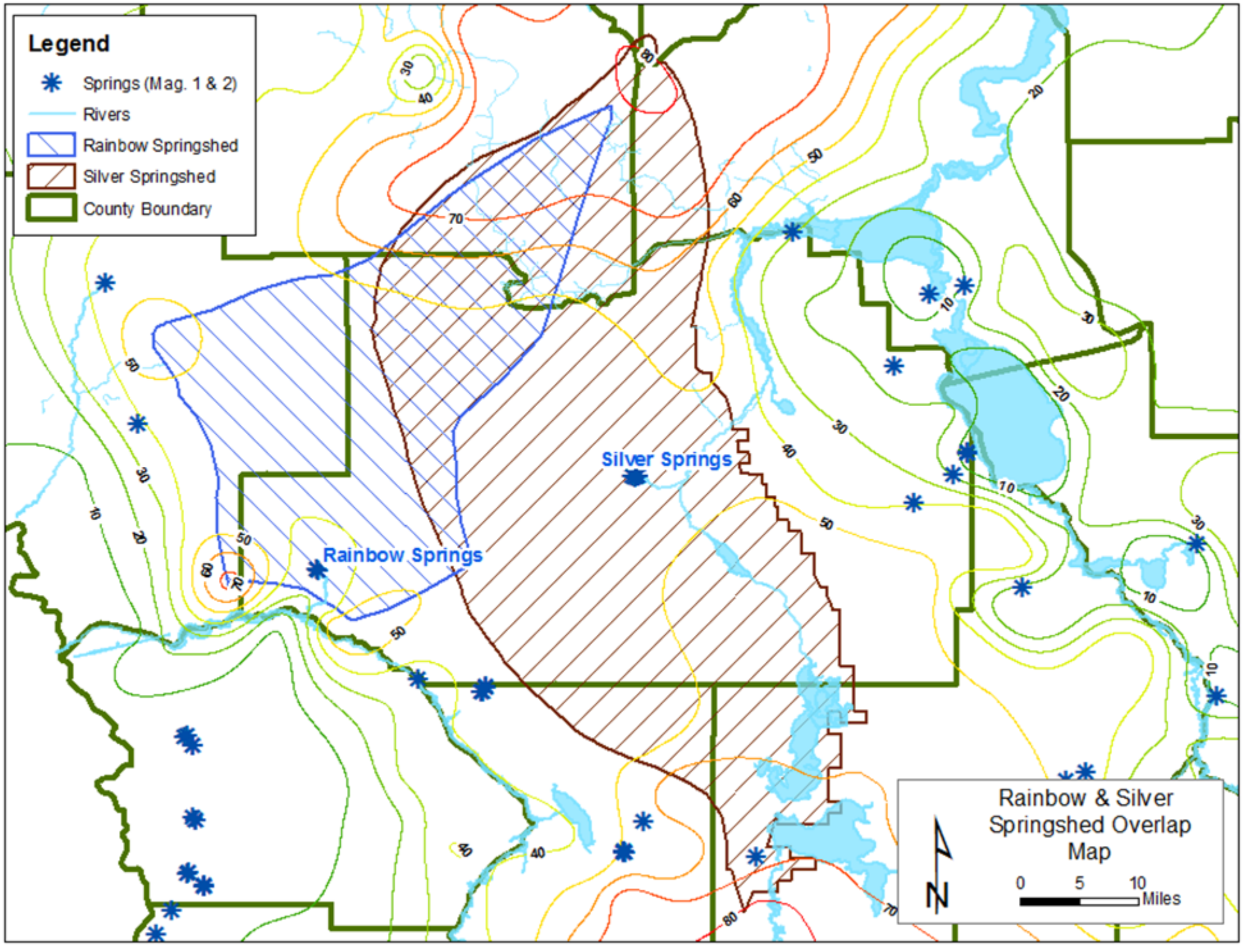
Silver and Rainbow Flows

- Divide between springsheds poorly defined
- Potentiometric surface nearly flat
- Slight decreases in aquifer levels shift springshed boundary by miles



Silver Springs Plant Community Changes

- Total submerged aquatic vegetation biomass declined by 21% from the 1950s to 2000s (Munch *et al.* 2007)
- Hydrilla not present in the river before 2010
- Vegetation changes cannot explain flow reductions

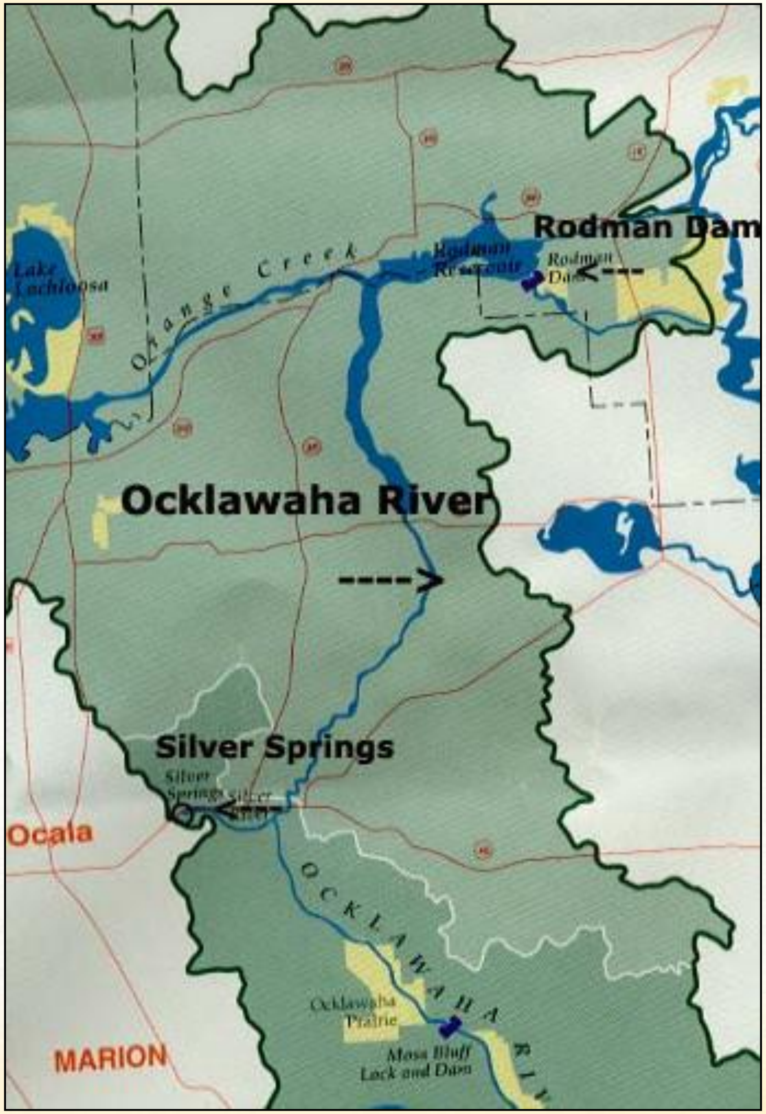
Photo by Bruce Mozert

Part 3: Silver Springs Lost Connectivity

- Kirkpatrick (Rodman) Dam closed in 1968
- 23 springs flooded along the Ocklawaha River
- Migratory fish populations declined and increased filamentous algae noted in Silver River by early 1970s

Ocklawaha River Restoration

- Removal of the Rodman Dam will allow:
  - Unimpeded passage for migratory fish and manatees
  - Re-establishment of a continuous floodplain forest connecting the Silver and St. Johns Rivers
  - Freeing 23 additional springs
- **The Ocklawaha River must run free to fully restore Silver Springs!**



Silver Springs: A 50-Year Retrospective Study

Summary of Findings

- Flow decreased by >20%
- NO_3-N increased by 176%
- Total plant biomass declined by 21%
- Nuisance algae increased by 370%
- Water clarity declined
- Ecosystem productivity declined by 27%
- Insect productivity declined by 72%
- Fish biomass declined by >90%

Munch *et al.* 2007

Silver Springs Restoration Actions

1. Implement water conservation practices throughout north Florida to reduce existing groundwater pumping
2. Reduce fertilizer use throughout the springshed
3. Enhance all wastewater facilities to advanced N removal
4. Provide tax incentives for conversion of sensitive karst lands to forestry
5. Remove the Rodman Dam

Photo by Bruce Mozert

Detailed recommendations for comprehensive Silver Springs restoration are presented in the full report at:

www.floridaspringsinstitute.org.

Dr. Knight will discuss at a future BMAP meeting