Water Measurement Presentation

Compact Implementation Technical Team

March 15, 2016

Overview of Presentation

a) **Historical Perspective**

b) **Review of some hydrologic trends**

c) **Role of Water Measurement, and reference within Compact**

d) **Current Water Measurement Proposal**

Some Units for Describing Water

Acre-foot [af]: volume of water which inundates one acre to a depth of one foot. Commonly used for reservoirs and seasonal volumes in canals or streams

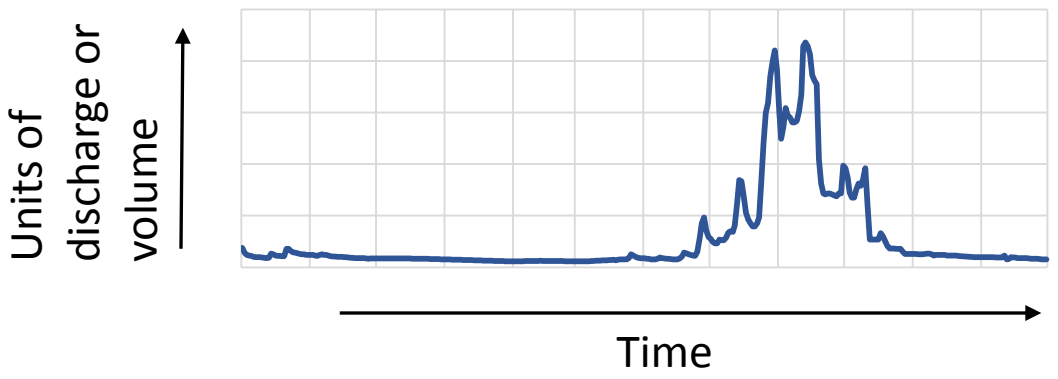
Cubic feet per second [cfs]: near- instantaneous discharge of water across a cross section of stream or canal

1 cubic foot per second = 448.8 gallon per minute

1 cubic foot per second over a day = 1.983 acre-foot

1 cubic foot per second over a year = 724 acre-feet

Graphical representation of water - hydrograph



Historical Perspective

1860

1865 – High water year, flooding documented in western Montana papers. Portland, Ore. floods

1860's-1870's – Indian irrigation ditches constructed in Jocko Valley, Vanderburg Ditch on Finley Creek - 1864

1875

Around 1885, headworks and canal started at present location of Jocko K Canal

1890

1894 – Flood of record, lower Flathead River = 110,000 cfs; next largest flood 1928 = 82,800 cfs

1905

1906 – 1918 – early U.S. Geological Survey streamflow records Jocko, Mission, Little Bitterroot Valley, records available on USGS website Much of the measurement predates FIIP irrigation diversion

1908 – Flood of record for much of Western Montana, Jocko River 7,500 cfs; Post Creek 2,800 cfs

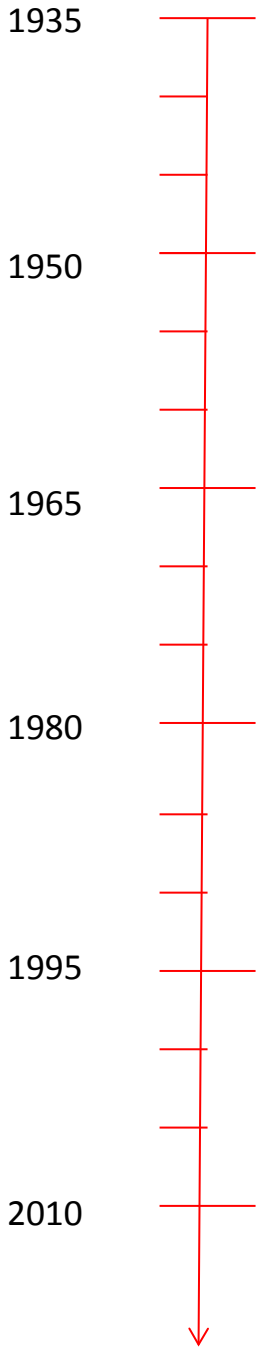
1916 – Regional high water year, including Reservation

1920

1928 – Regional high water year, including Reservation

1929 - 1944 – Most severe continuous drought in measured record for Montana

1935



1939 through 1946 – Compilations of water supply and water use for FIIP prepared by US Indian Irrigation Service and USDOI Office of Indian Affairs Irrigation Division

1941 and 1944 – Droughts of record for western Montana

1948 – Regional flood year, second largest recorded flood on Jocko River

Starting in 1940's, FIIP initiated stream and canal measurement program
Approximately 70 ratings were developed spanning into 1960's. Records indicate measurement program very limited after 1960's

1964 – Regional flood year, FIIP Project Engineer reports 3.92" rain in 42 hours, many FIIP canals and headworks destroyed

1974 – Regional flood year

1982 – CSKT Water Measurement Program starts. USGS cooperative program starts, USGS stream gaging information available 1982 - present

1987 – Measurement and compliance for Interim Instream Flow and Minimum Reservoir pool levels begins

1987 and 1988 - Severe drought in western Montana

1992 – Severe single year drought

1997 – High water year, Jocko River peaks at 2,710 cfs

2001 – Drought, one of five lowest water years on record

2005 – Very elevated peak flows – driven by rain event, not snowmelt

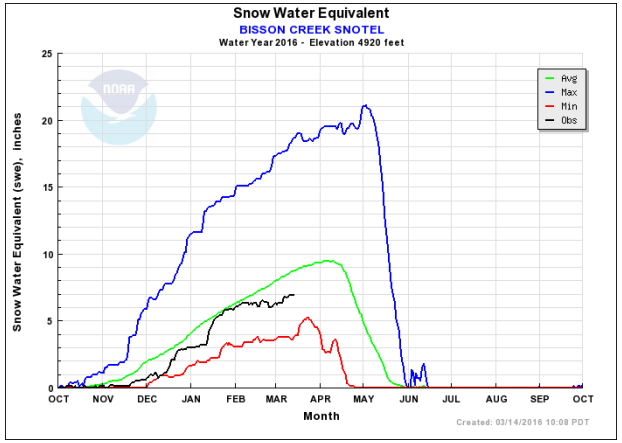
2011- volumetrically very high water year, similar to 1997 – sustained high flows

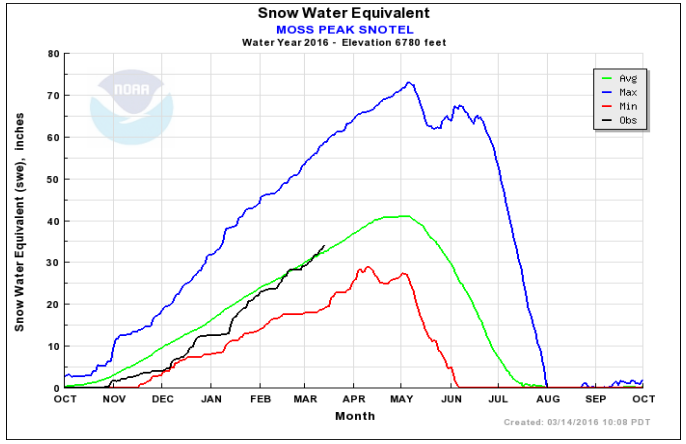
2015 – Low water year, very below average snowpack, below average precipitation, above average temperatures, strong el nino signature through later 2015 carrying into 2016

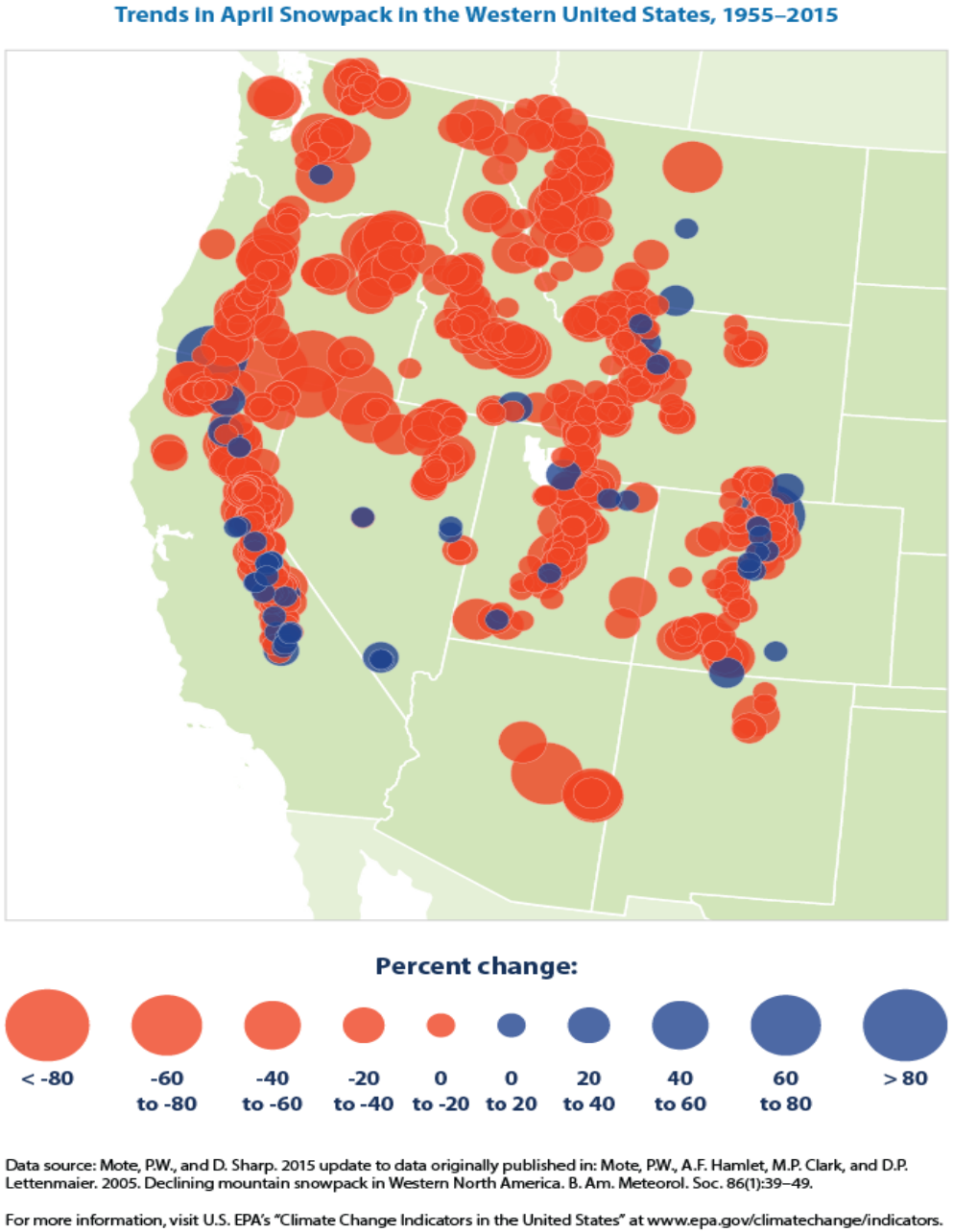
Northwest Montana watersheds are considered either snow-dominated or rain and snow dominated

Typically > 75 % of surface runoff comes as snowmelt in the April – July period

This pattern is widely recognized to be changing, with earlier runoff and a greater percent of precipitation occurring as rainfall





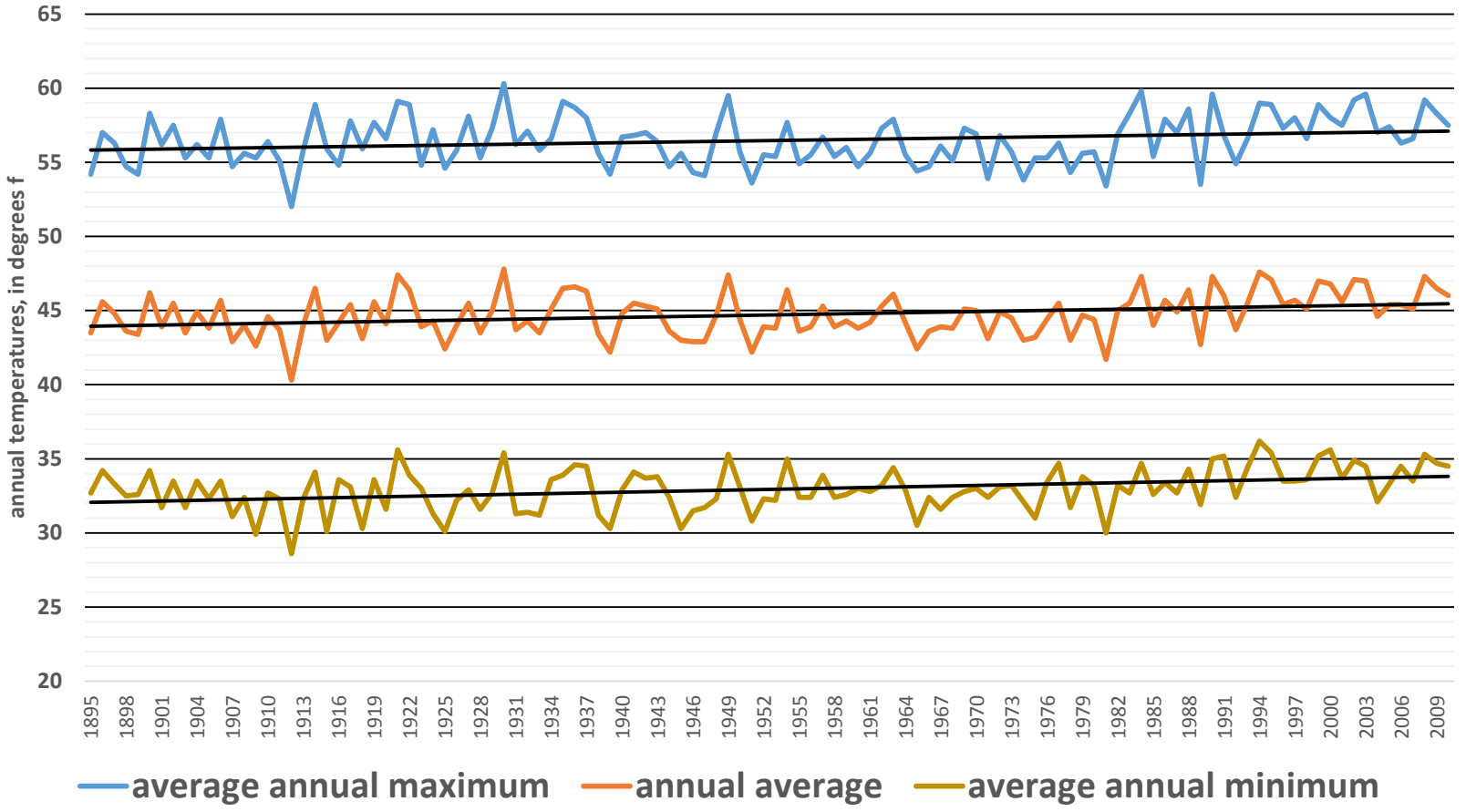


Snow observations are consistent with longer-term temperature data

Missoula first order weather station (USC00245740)

Air temperature data 1895 – 2015

For each trend line air temperature has increased by approximately 1.5 degrees Fahrenheit over the time period

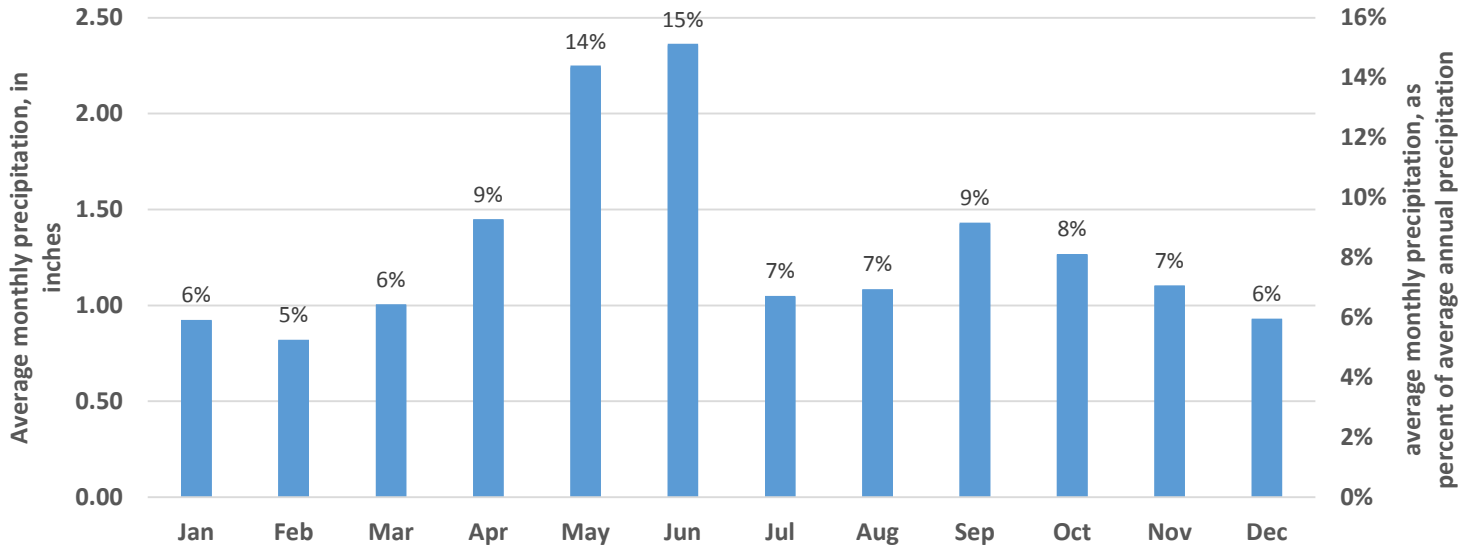


Saint Ignatius weather station Precipitation patterns

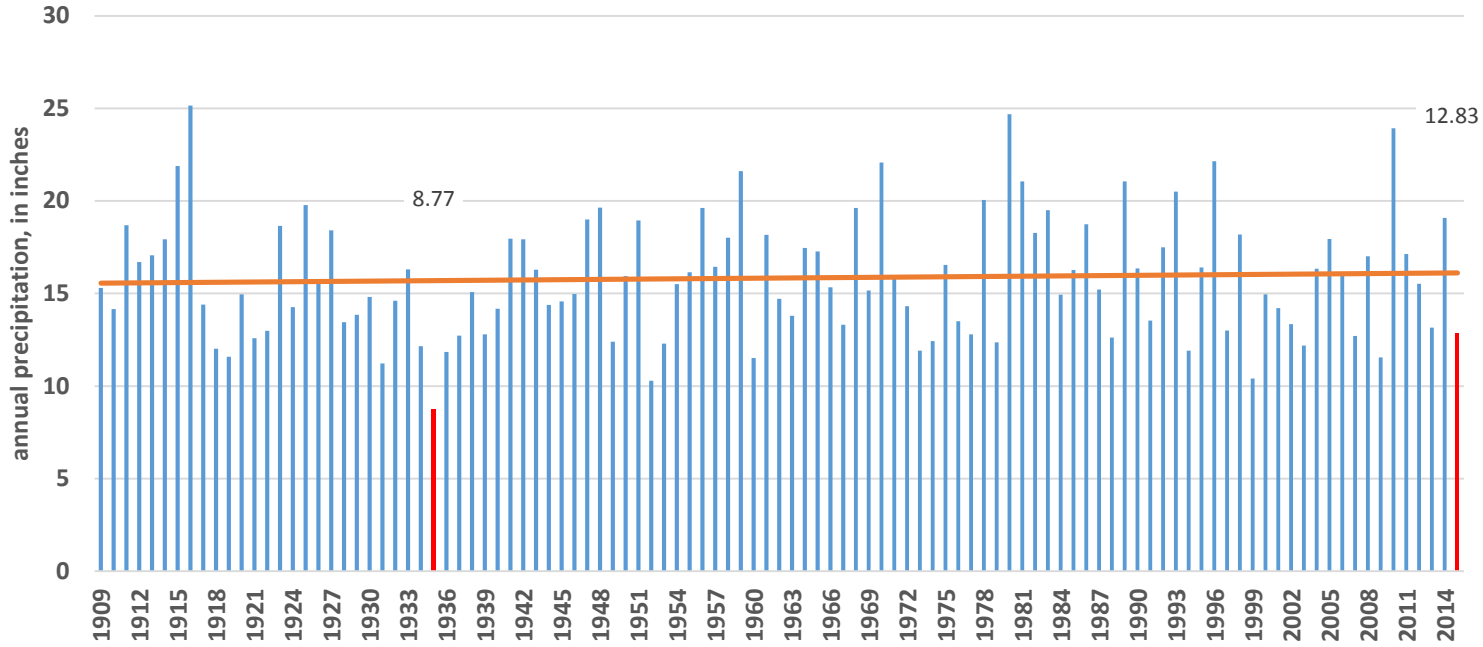
a) **Monthly precipitation patterns using 1909 – 2015 average monthly values**

b) **Average annual precipitation for 1909 – 2015 period (average = 15.84 inches). Orange is trend line.**
   a) **1935 lowest annual precipitation in 107 year period;**
   b) **2015 24th lowest annual precipitation in last 107 years**

a)

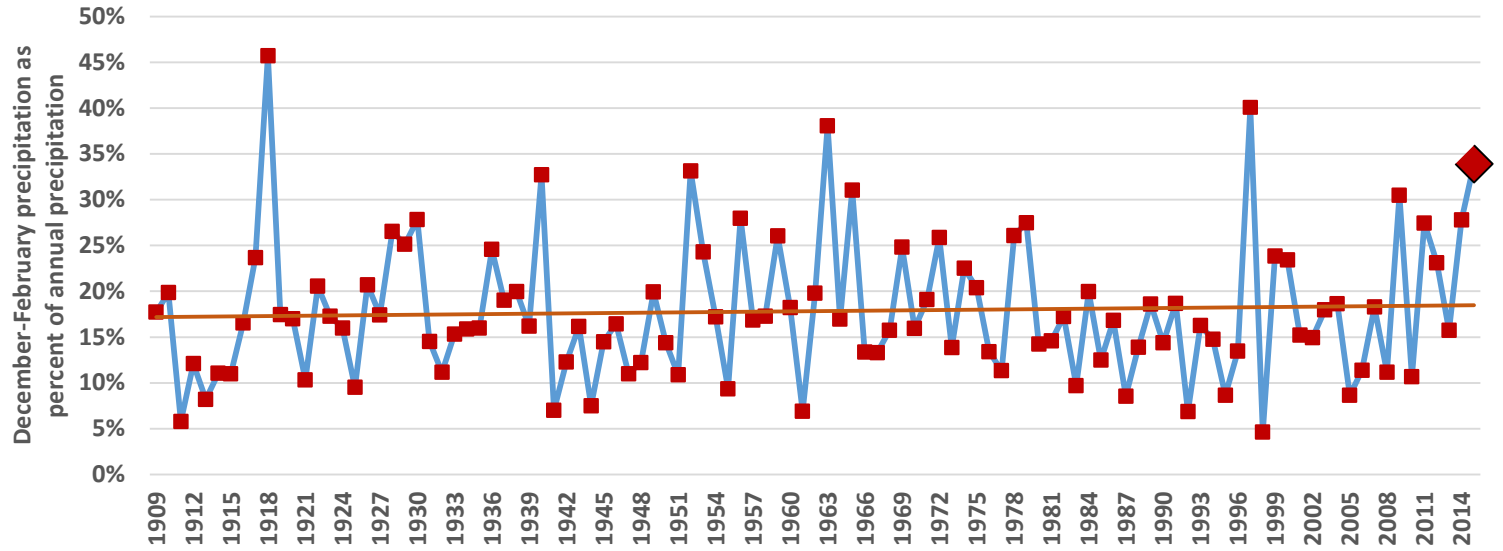


b)



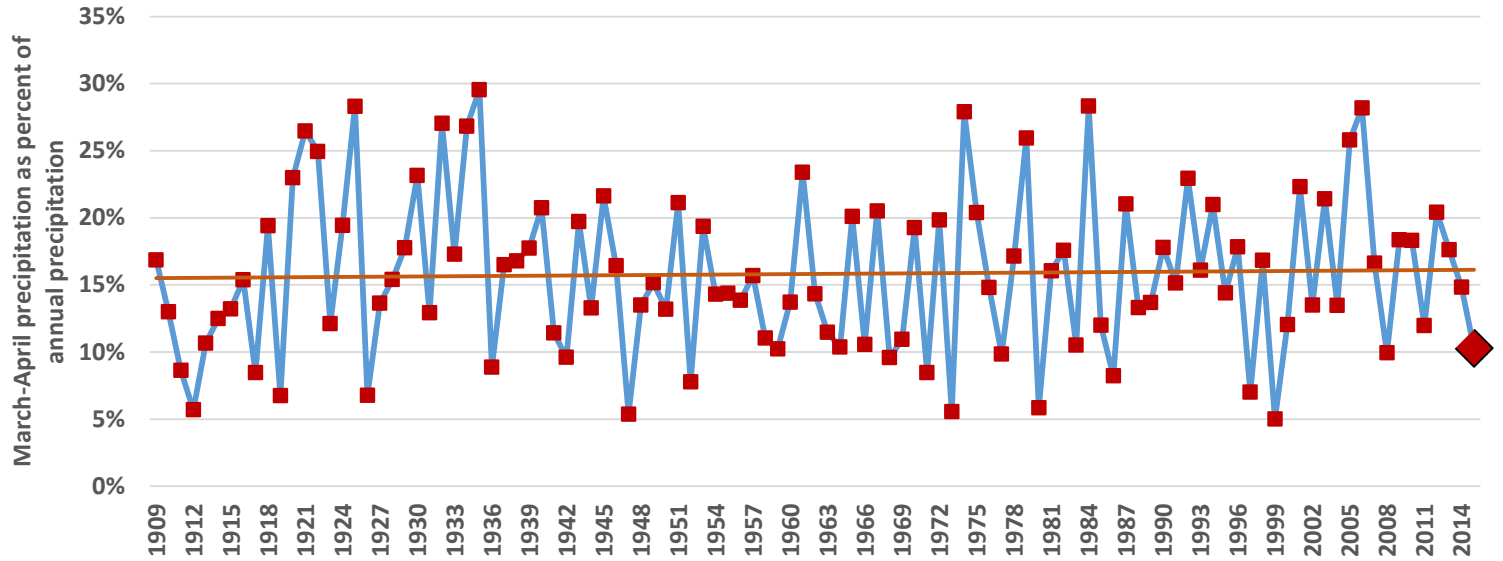
c) St Ignatius station December – February precipitation as percent of each years annual precipitation (average = 18%). Orange is trend line

c)



d) St Ignatius station March and April precipitation as percent of each years annual precipitation (average = 16%). Orange is trend line

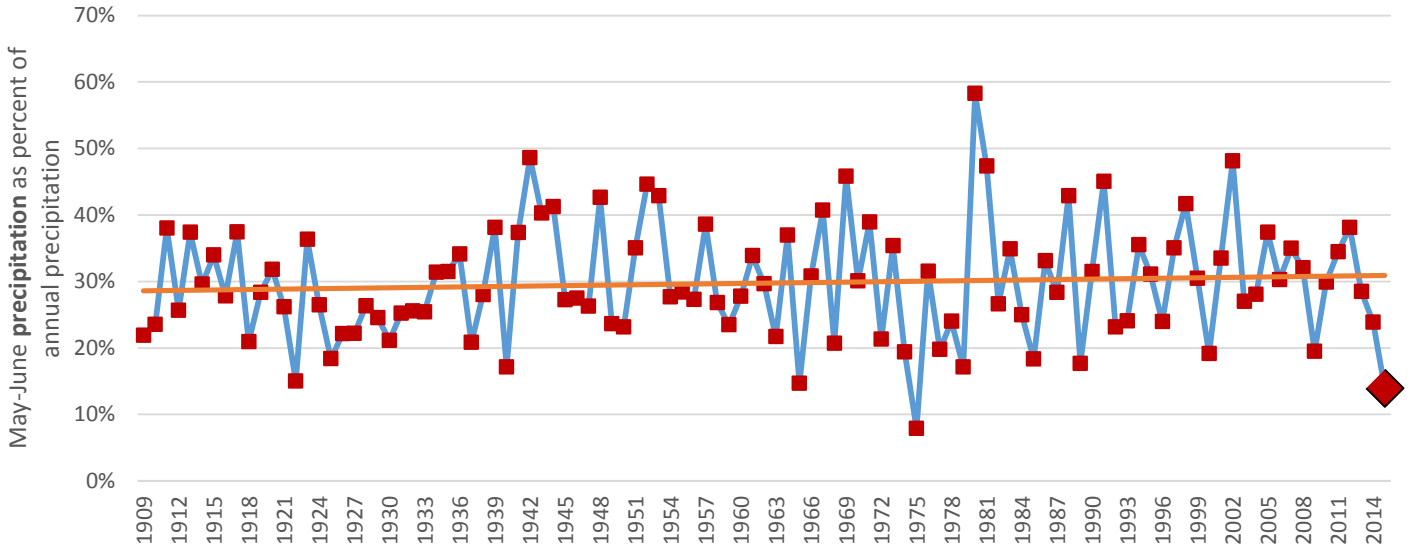
d)



2015

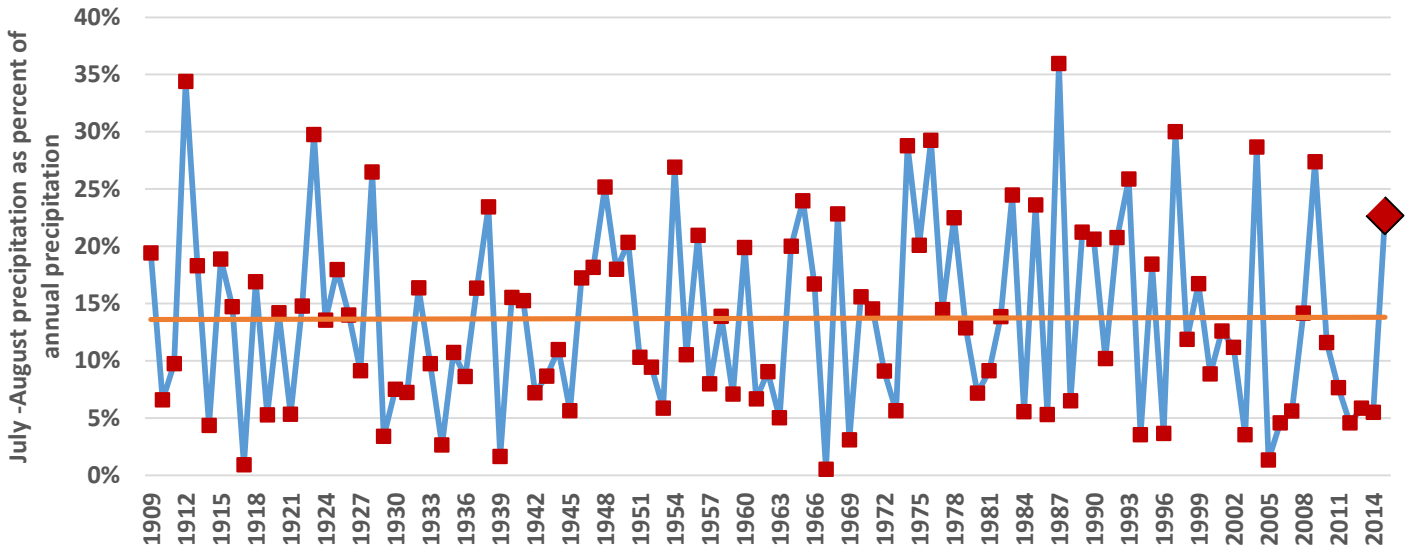
e) St Ignatius station May and June precipitation as percent of each years annual precipitation (average = 30%). Orange is trend line

e)



f) St Ignatius station July and August precipitation as percent of each years annual precipitation (average = 14%). Orange is trend line

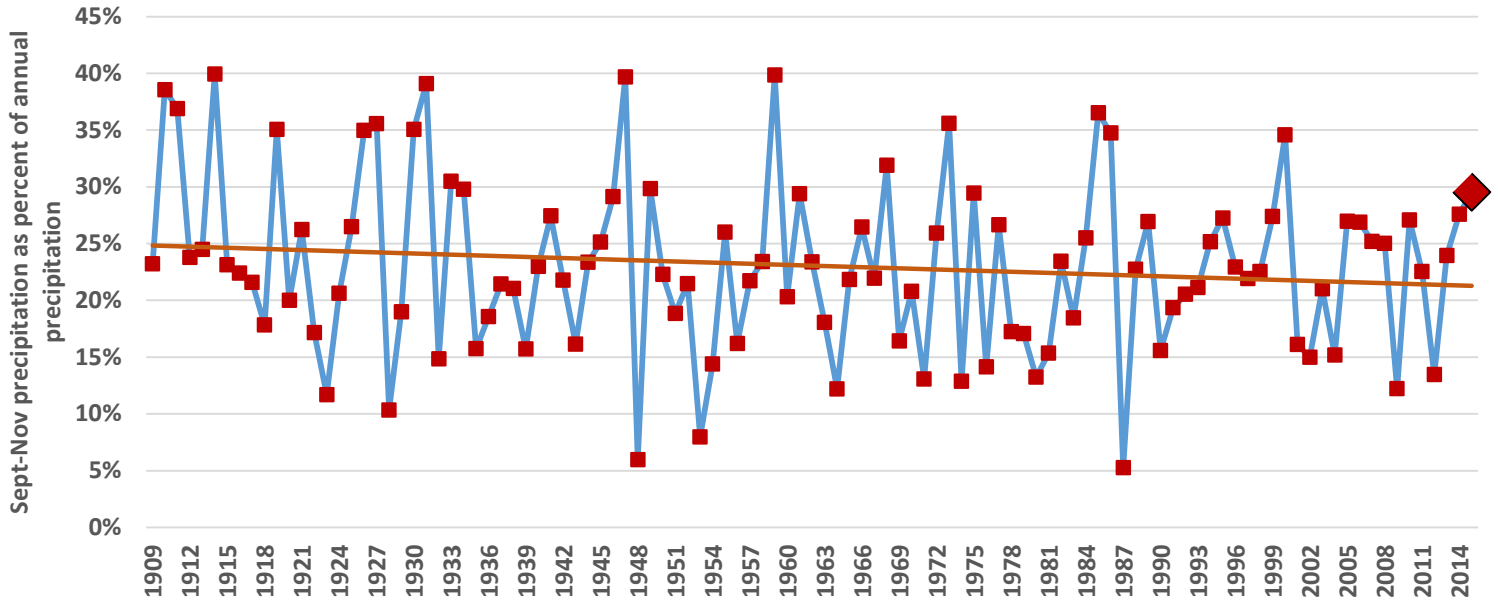
f)



2015

g) September – November precipitation as percent of each years annual precipitation (average = 23%). Orange is trend line

g)



2015

Swan River at Bigfork
USGS station 12337000

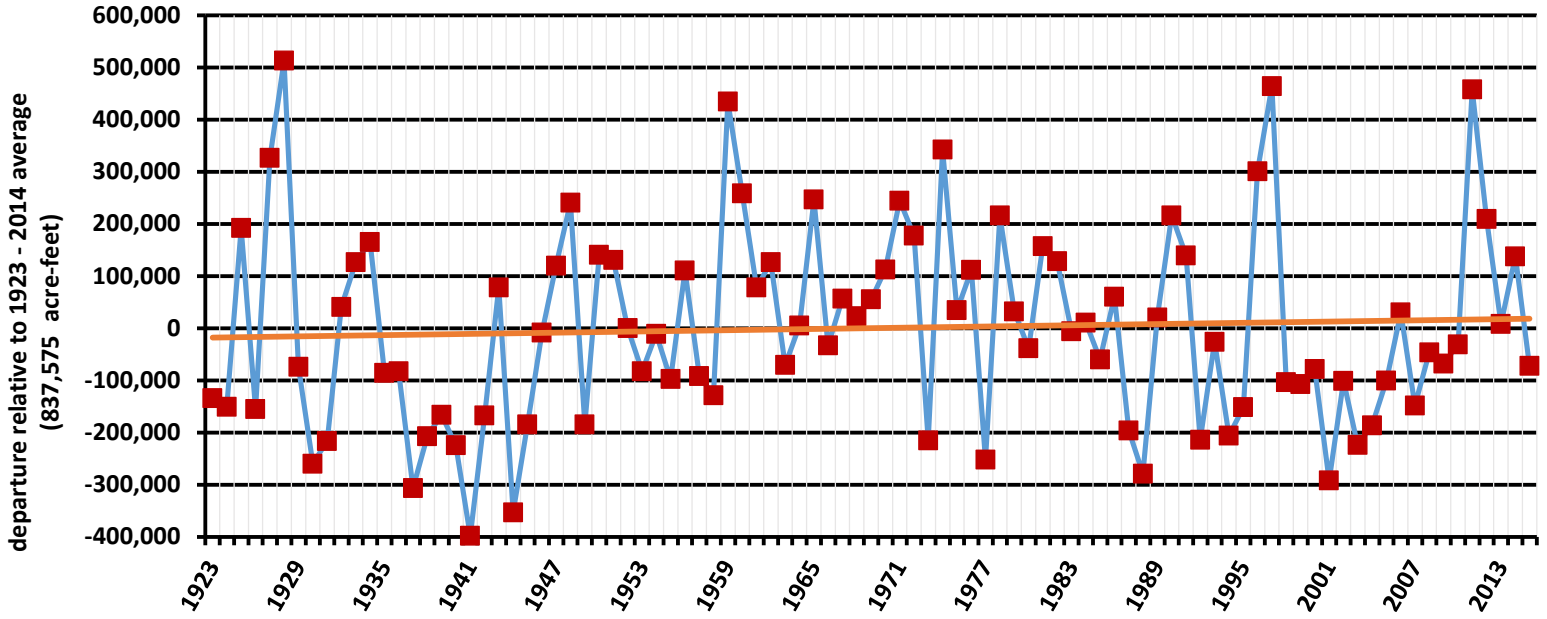
Long-term representative natural flow gage for region

Surplus – deficit plots

a) **Shows (+ or –) departure of yearly average flow volume from long-term average flow volume. Orange is trend line**

b) **3-year moving average smooths annual values helping to illustrate multi-year patterns, such as droughts of 1940's and early 2000's**

a)



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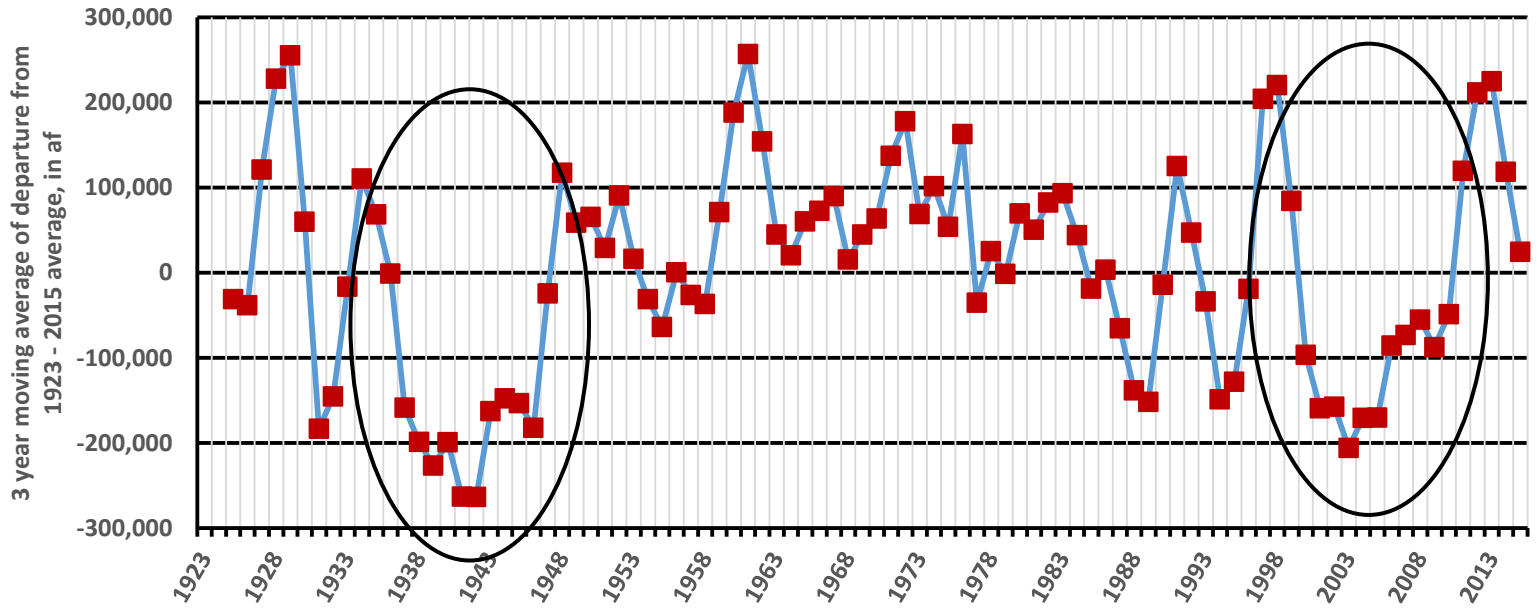


Swan River at Bigfork
USGS station 12337000

<u>April – September runoff volume as percent of annual runoff volume (average = 76%)</u>

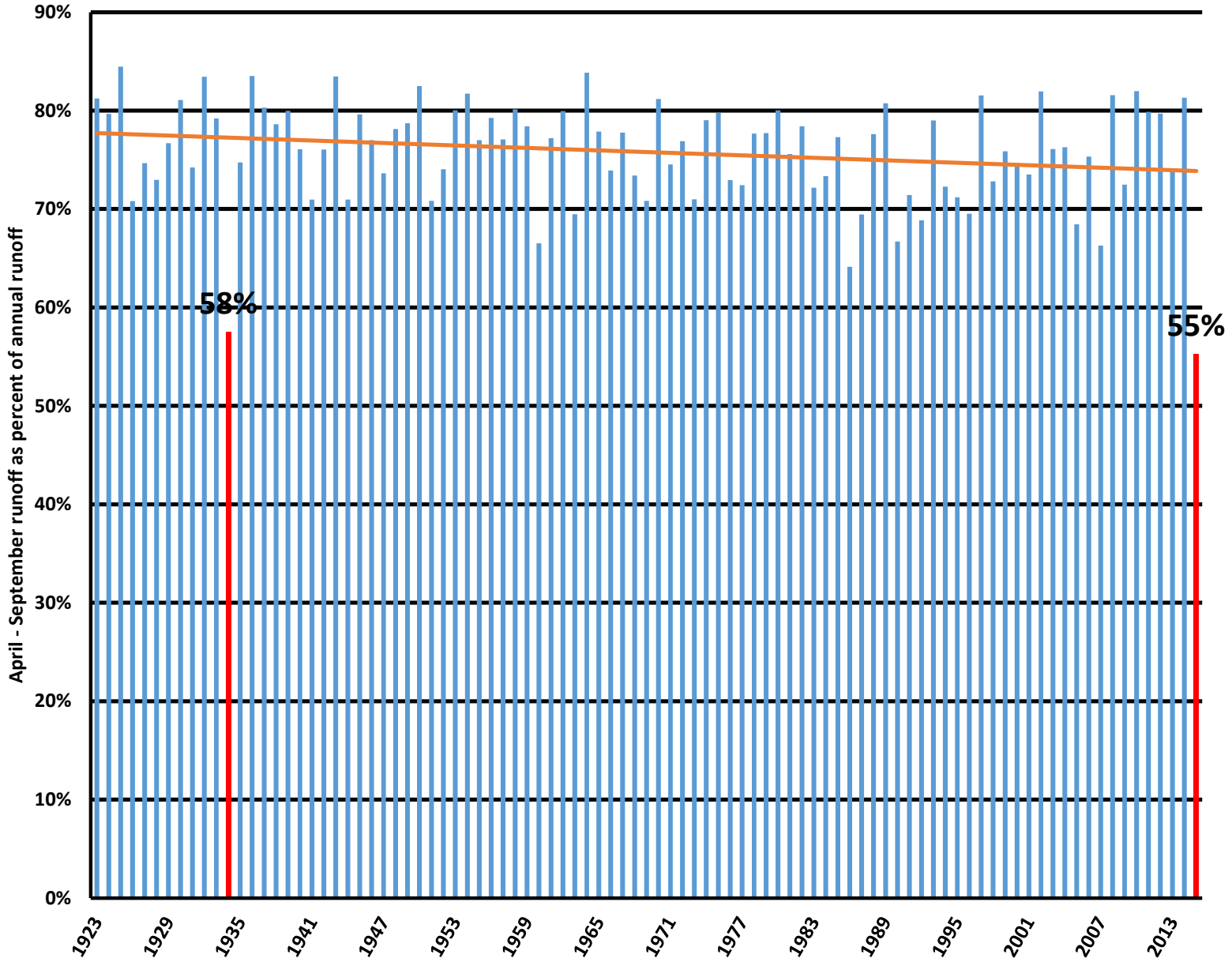
Red bars

1934; 58 %

2015; 55 %

2015 – earliest peak on record
March 19th

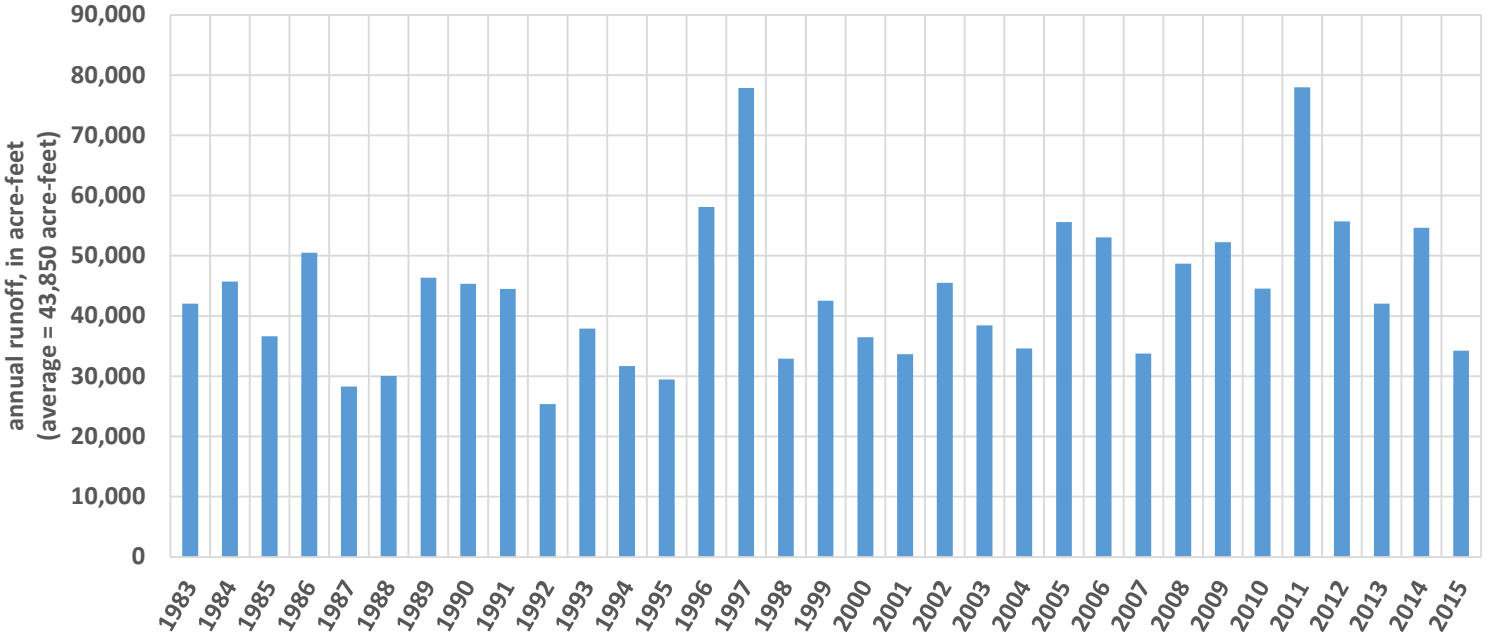
Orange is trend line
April - September runoff is decreasing as percent of annual runoff volume at this station



Natural Flows on Reservation

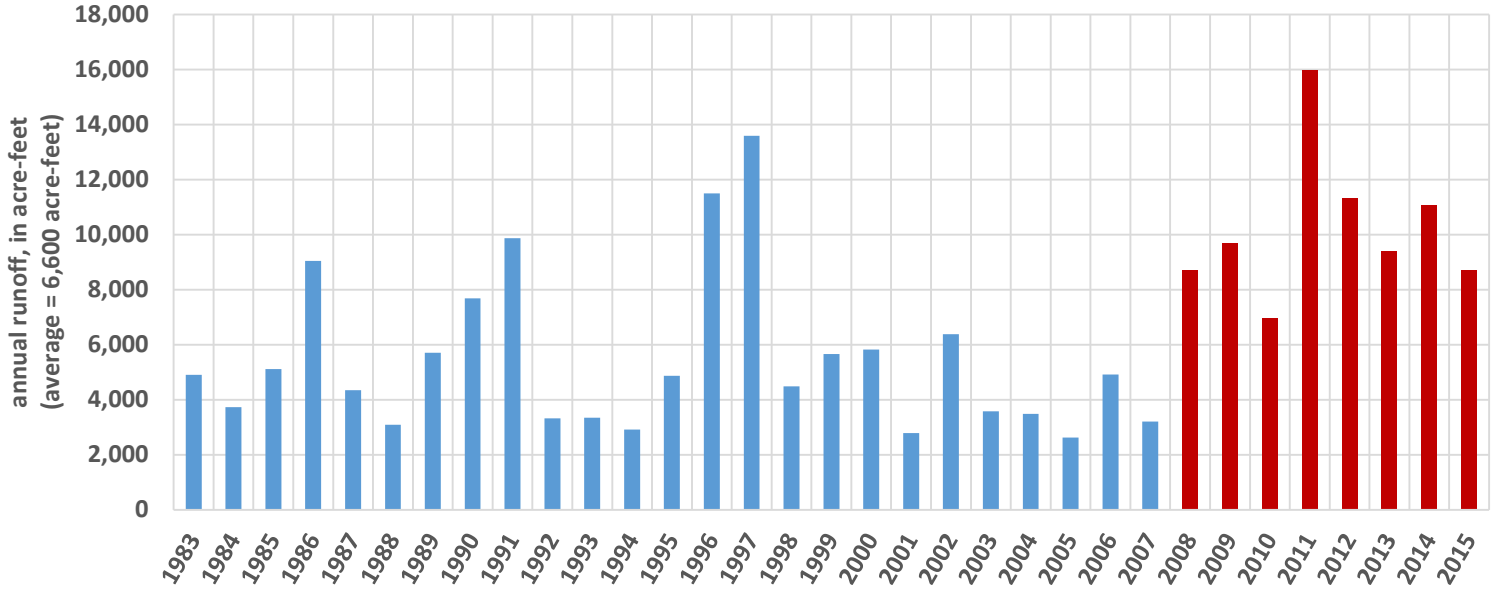
a) Annual runoff South Fork Jocko River (USGS gage 12381400)

a)



b) Annual runoff Mill Creek (USGS gage 12372450)

b)

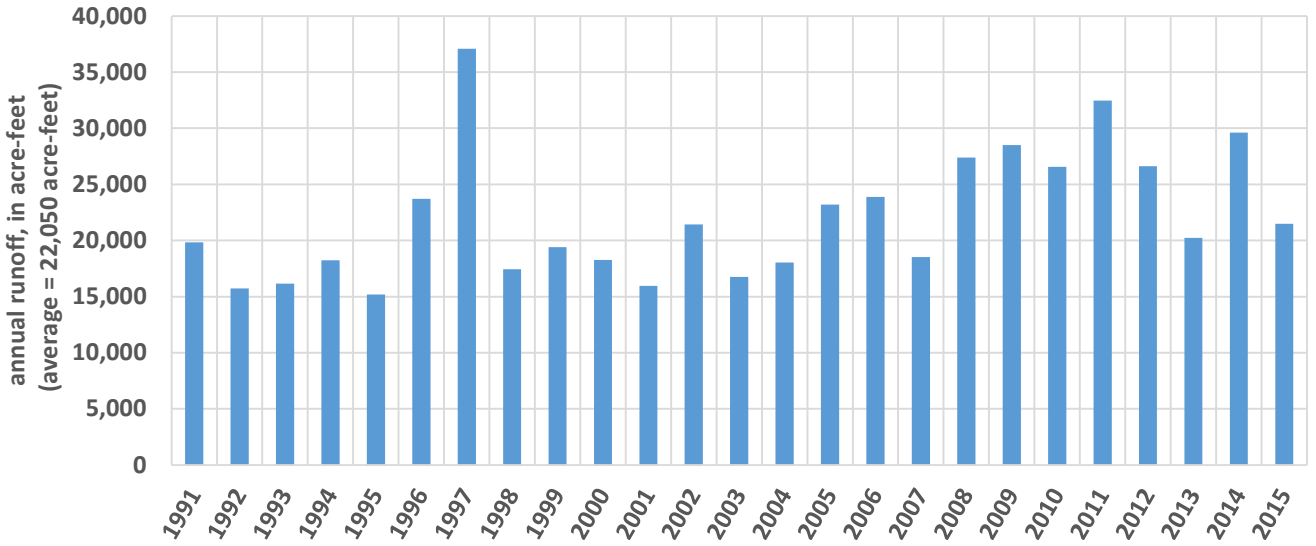


Post- Chippy Creek fire

Regulated Flows on Reservation

a) **Annual runoff Middle Fork Jocko River (CSKT gage 5100.00). Average diversion from Placid Creek into Jocko Reservoirs = 6,495 acre-feet**

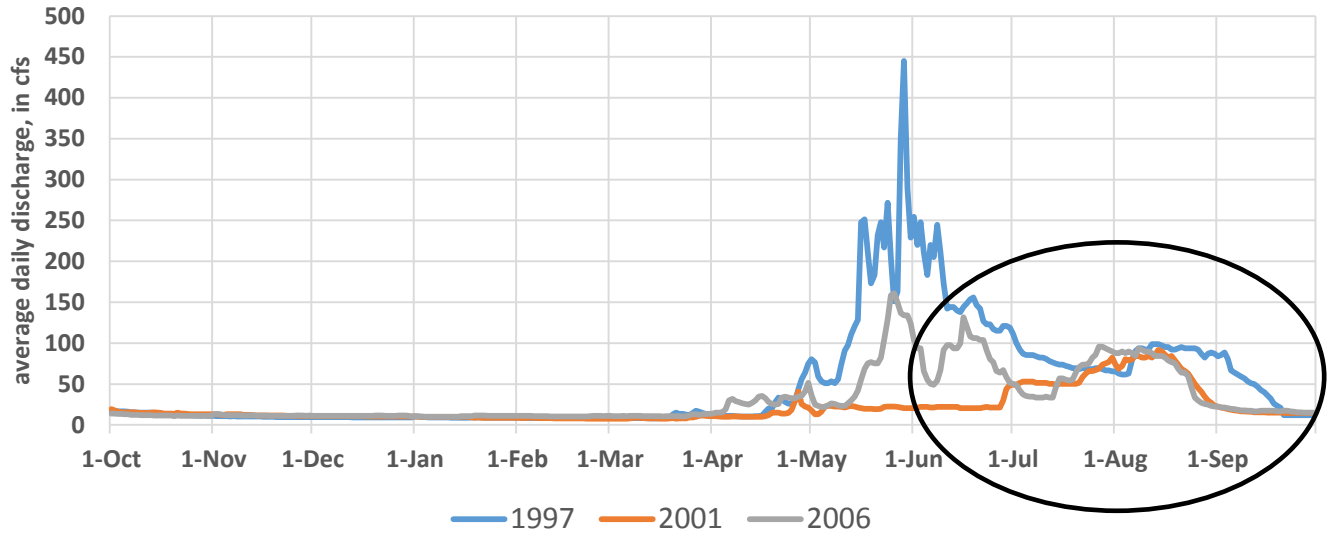
a)



b) **Average daily discharge hydrograph Middle Fork Jocko River (CSKT gage 5100.00) for**
   a) **1997 – wet year**
   b) **2001 – dry year**
   c) **2006 - ~ average year**

High flows in MF shifted to later in summer due to reservoir releases

b)

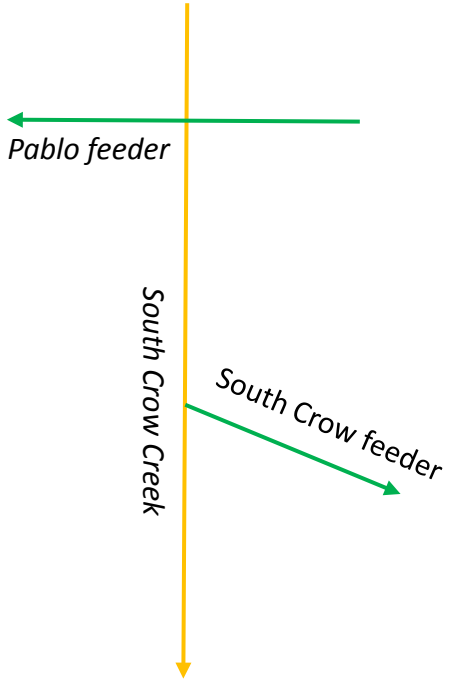


◯ period when reservoir releases moved down river

Two views of downstream flow patterns for South Crow Creek

a) **Wet year – 1997**

b) **Dry year - 2001**



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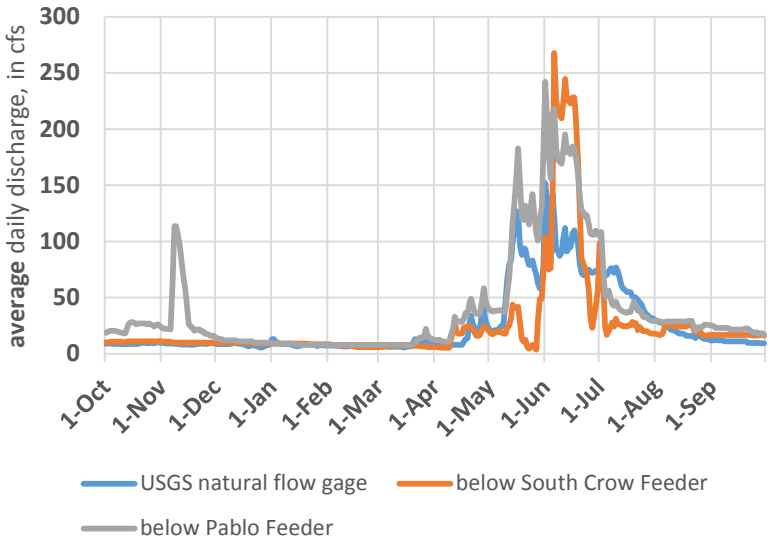

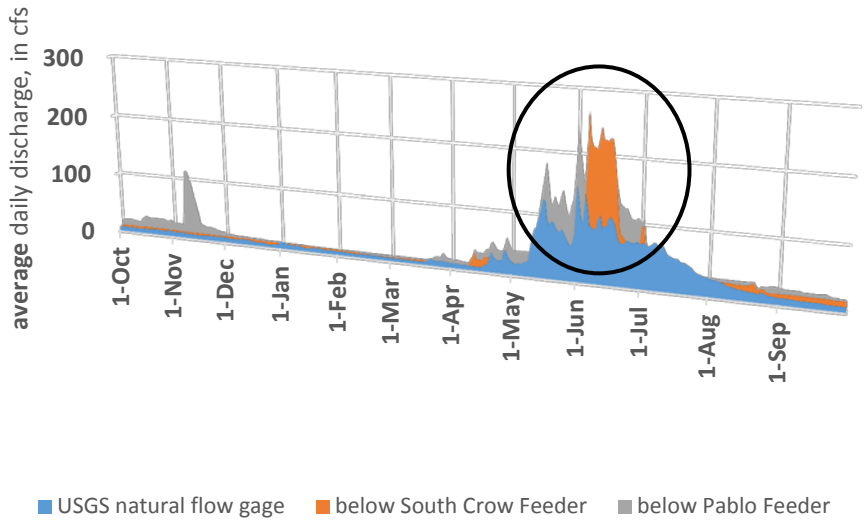

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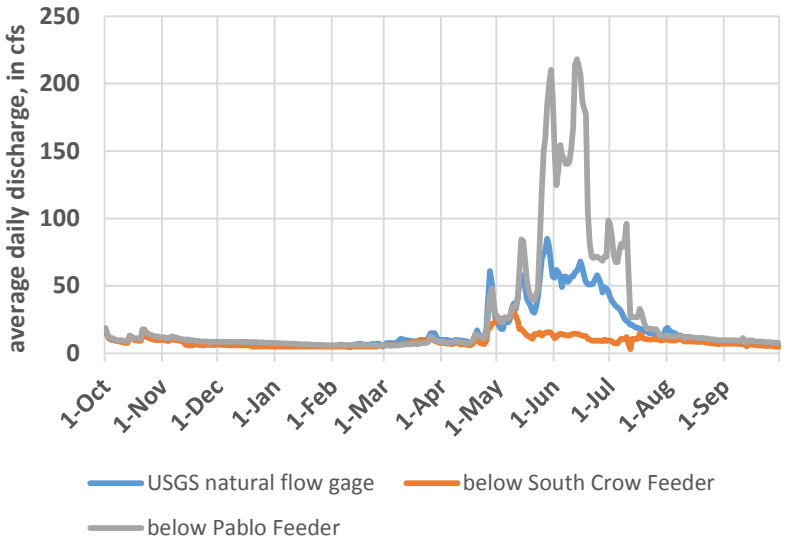
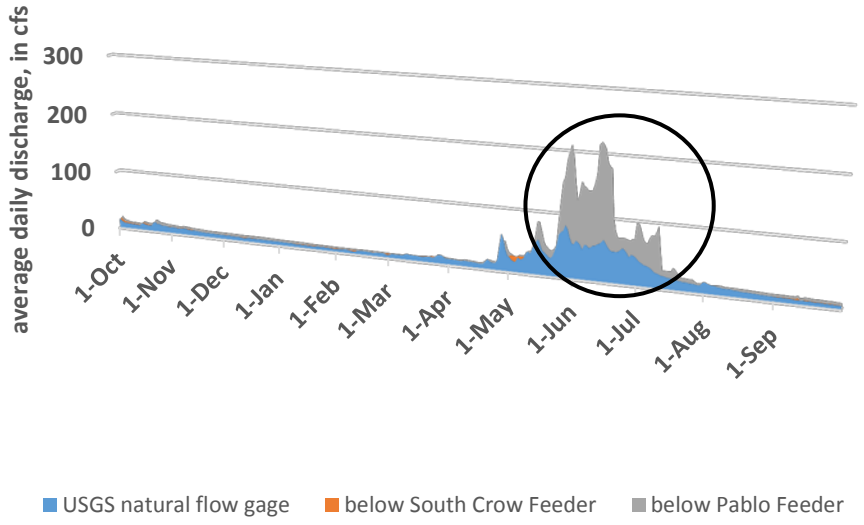




Little Bitterroot Watershed

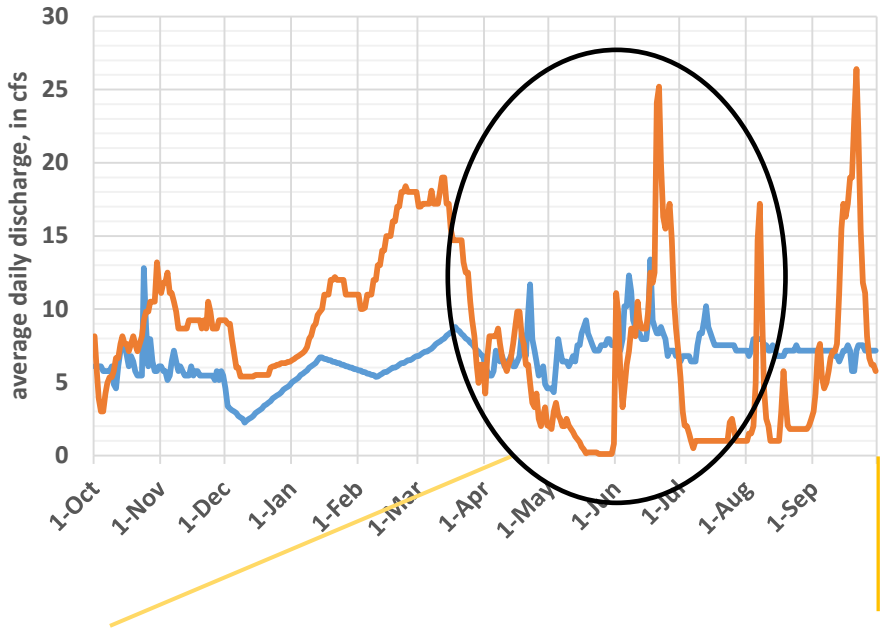
a) **Little Bitterroot River near Niarada 1909 – 1910 USGS gage 12374000: snowmelt – patterned hydrograph**

b) **Little Bitterroot River 2010 – moderate dry year**
   a) **Blue – below Camas A Canal**
   b) **Orange near mouth**

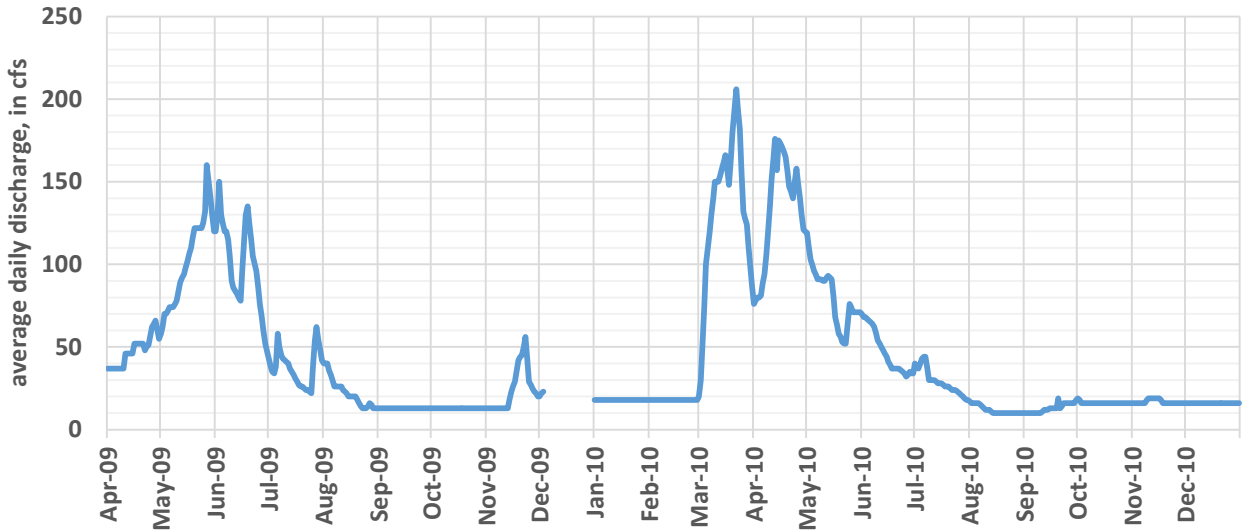
609 sq mile drainage area at mouth

c) **Summer period for 2010**

b)



a)



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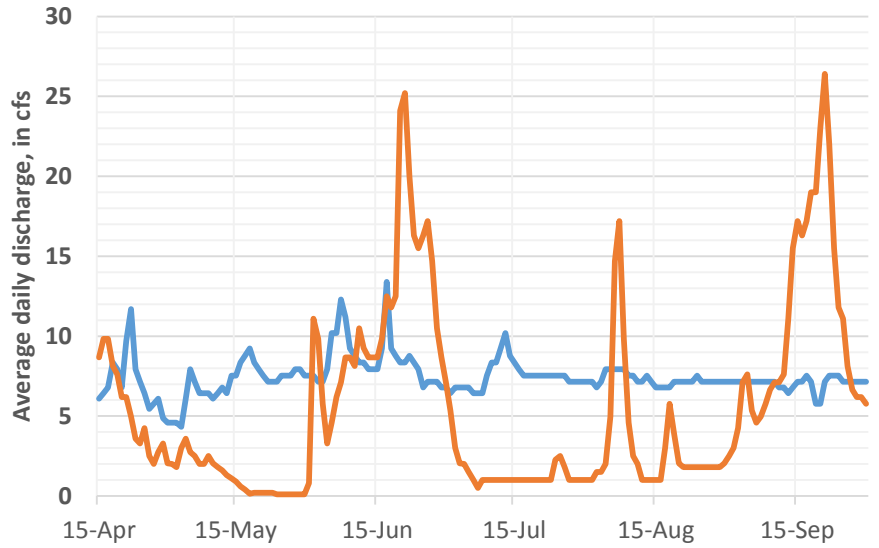
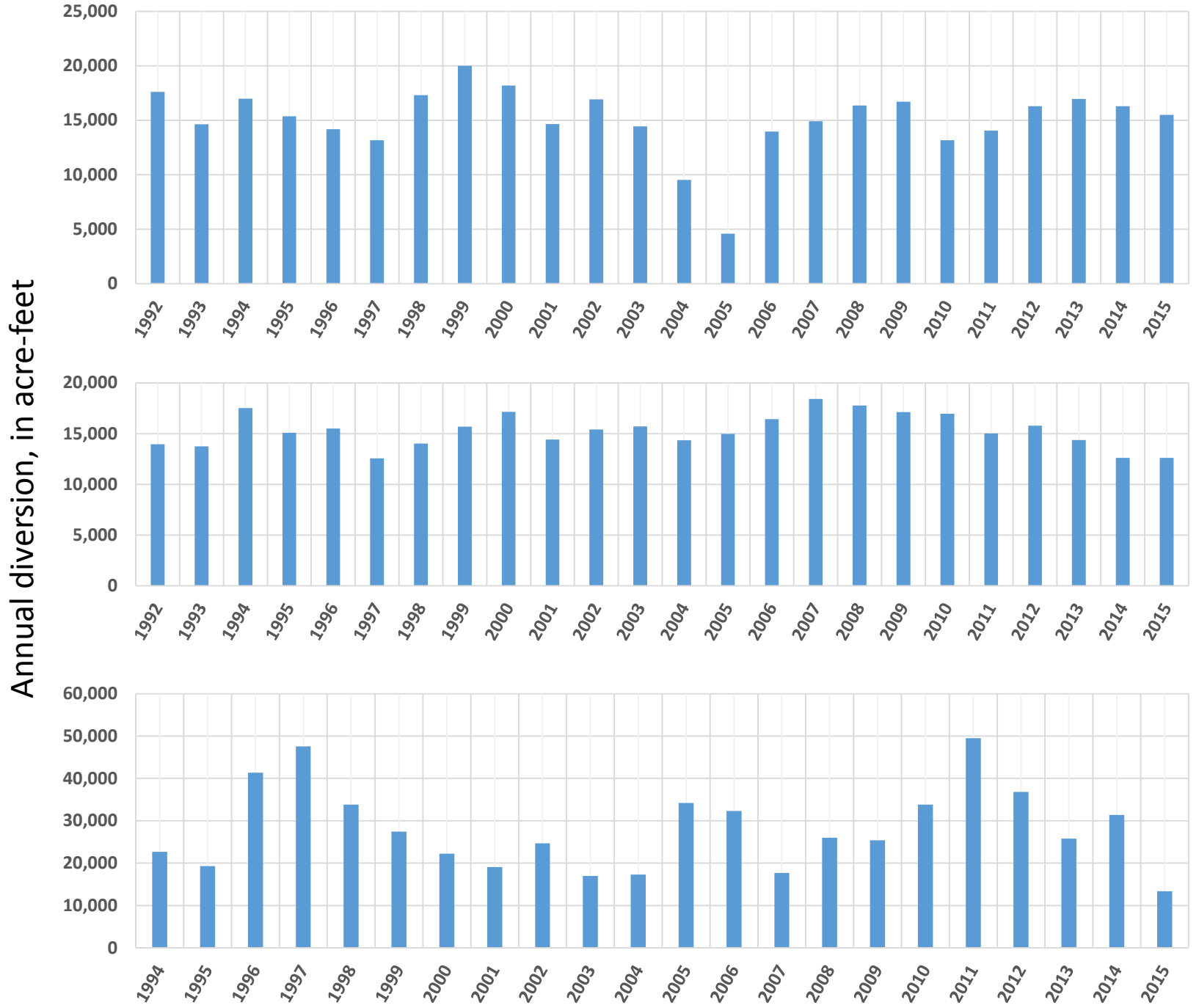


Canal diversion records

a) Camas A Canal below Mill Creek

b) Moiese A Canal below Headworks

c) Pablo Feeder Canal below Pablo Drop above Flathead Pump Canal



Water measurement is key element for water management

a) **Complexity of surface water supply for FIIP. Unlike many irrigation projects, FIIP relies on a large number of smaller sources to produce an aggregate water supply**

b) **Complexity of canal network [approximately 1 mile of maintained canal for every 128 irrigated acres]**

c) **Variability of annual water supply and the timing of water supply**

d) **Limitations of Reservoir storage capacity**

Area	~ average runoff derived from mountain runoff	Maximum storage volume	Storage as % of ~ average runoff
Jocko	198,000 acre-feet/year	11,697 acre-feet	5.9 %
Mission	215,000 acre-feet/year	106,988 acre-feet	49.8 %
Little Bitterroot	39,000 acre-feet/year	45,351 acre-feet	116.3 %

e) **Competing demands for a limited water supply – federal irrigation project, extensive private irrigation, instream flows**

Compact References to Water Measurement

a) **Articles IV. C., D., and E., recognize the role of water measurement and Article IV.F confirms this, explicitly identifying comprehensive water measurement as essential**

b) **Appendix 3.5, CITT responsibilities – identifies water measurement as a task in several locations**

c) **Appendices 3.1 – 3.7 are, in part, based on water measurement activities**

d) **Instream flows, River Diversion Allowances and determination of wet through dry year-types are all based on active water measurement**

Water Measurement Proposal - Builds on current CSKT Water Measurement Program

a) Program currently maintain 38 stream stations and 25 canal stations

b) Program has tracked compliance at 28 interim instream flow locations for the last 30 years

c) Twenty of the currently measured stream stations are identified as instream flow [MEF/TIF] locations in the Compact

d) Twenty of the currently measured canal stations are identified as River Diversion Allowance locations in the Compact

e) Three of the currently measured irrigation return flows are maintained to help FIIP comply with the Biological Opinion for Operation and Maintenance of the Project

f) Forty five current stations are telemetered and the Program is working to expand telemetered sites and improve the website for data viewing

Water Measurement Proposal - Perspective

a) Meet the Compact requirements for River Diversion Allowance and Instream Flow measurement locations

b) Meet the Compact requirements for natural flow measurement locations to determine wet through dry water year types

c) Add a small subset of larger irrigation return flow stations to track progress

d) Apply a lower intensity monitoring protocol at locations with low flow volumes and/or headworks management that does not require system-level coordination

e) Upgrade all measurement locations to telemetry

f) Provide universal access to telemetered data via website

g) Over time install artificial controls at canal measurement locations to reduce long-term costs and improve operational control on canals

Water Measurement Proposal - Numbers

Location type	Existing with telemetry	New with telemetry	Upgrade to telemetry	Monitoring protocol
Instream flow	14	1	6	11
River diversion allowance	16	17	4	8
Natural flow	7		3	
Irrigation return flow	3	3		

Water Measurement Proposal - Locations

Tables in Compact Appendices

http://dnrc.mt.gov/divisions/reserved-water-rights-compact-commission/confederated-salish-and-kootenai-tribes

Tables in measurement proposal

http://dnrc.mt.gov/divisions/reserved-water-rights-compact-commission/cskt-montana-compact-technical-team-meeting-information

Station name	Station type	Measurement plan
Middle Fork Jocko River	IIF/MEF/TIF	Existing equipment
North Fork Jocko River	IIF/ MEF/TIF	Existing equipment
Falls Creek below Tabor Feeder	MEF/TIF	Monitoring protocol
S-14 Creek below Tabor Feeder	MEF/TIF	Monitoring protocol

Jocko Area

Middle Fork Jocko River below Tabor Feeder Canal near mouth

all values in cfs	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
MEF	9	9	10	18	26	22	20	9	9	9	9	9
TIF Normal Year	9	9	11	21	26	26	44	72	44	25	14	10
TIF Wet Year	11	11	12	20	52	96	92	60	58	38	12	9

North Fork Jocko River below Tabor Feeder Canal near mouth

all values in cfs	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
MEF	3	4	9	25	40	30	22	8	6	6	6	6
TIF Normal Year	4	4	14	26	70	44	24	12	10	10	12	8
TIF Wet Year	10	8	9	30	110	210	60	14	8	8	12	7

Falls Creek below Tabor Feeder Canal near mouth

all values in cfs	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
MEF	1	1	1	1	4	5	4	3	3	2	2	1

S-14 Creek below Tabor Feeder Canal near mouth

all values in cfs	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
MEF	0.1	0.1	0.1	0.2	0.4	0.7	0.4	0.3	0.2	0.1	0.1	0.1

Water Measurement Proposal – Locations
Maps attached to proposal

Budget and Schedule found in proposal