State Water Resources Control Board's Methods to Estimate Streamflow and Water Availability

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*** Note: Slide 21 has been updated since the workshop to reflect the revised NMFS/DFG draft guidelines issued June 17, 2002**

SWRCB's New Approach to Comply with the Water Code

- Purpose: To present the WAA requirements and methods to applicants, agents and public
- Previously, Division staff has provided much technical services to the applicant
- Shortage of technical staff & backlog of pending applications and change petitions
- From now on, the Applicant is responsible for completing WAAs and Enviro Docs

Topics

- Overview of California Water Rights
- Hydrologic Data used by SWRCB staff
- Estimating Demand using Water Rights Data
- Estimating Supply (Runoff)
- Cumulative Flow Impairment Index (CFII)
- Estimating Bypass Flow
- Evaluation & Improvement of Methods

Water in California

- 103 Rivers
- 5000 Lakes
- 1840 Miles of Shoreline
- 460 Groundwater Basins
- 700 “Major” Reservoirs
- 37,000 Water Rights

Major Types of Water Rights

- Riparian
  - Property must abut the source stream
  - Rights are correlative
- Pre-1914 Appropriative
  - For diversion of water on parcels that do not abut a stream
  - Right must have been initiated before December 19, 1914

Major Types of Water Rights, cont.

- Post-1914 Appropriative
  - For any storage of water, regardless of whether the parcels abut a stream
  - For direct diversion of water on land that does not abut a stream
  - Initiated after December 19, 1914
- Other Post-1914 Water Rights
  - Stockwatering Certificates
  - Small Domestic Registration
  - Small Livestock Registration

General Water Right Priorities

- 1) Riparian
- 2) Appropriative

  "First in Time -- First in Right"

  – Pre-1914

  – Post-1914

Permit Required

- Post-1914 Appropriative Water Rights
- Stockwatering Certificates
- Small Domestic Registration
- Small Livestock Registration

Permit Not Required

- Use of purchased water
- Percolating groundwater
- Riparian right (Statement Required)
- Pre-1914 right (Statement Required)
- Springs w/o natural outlet to stream

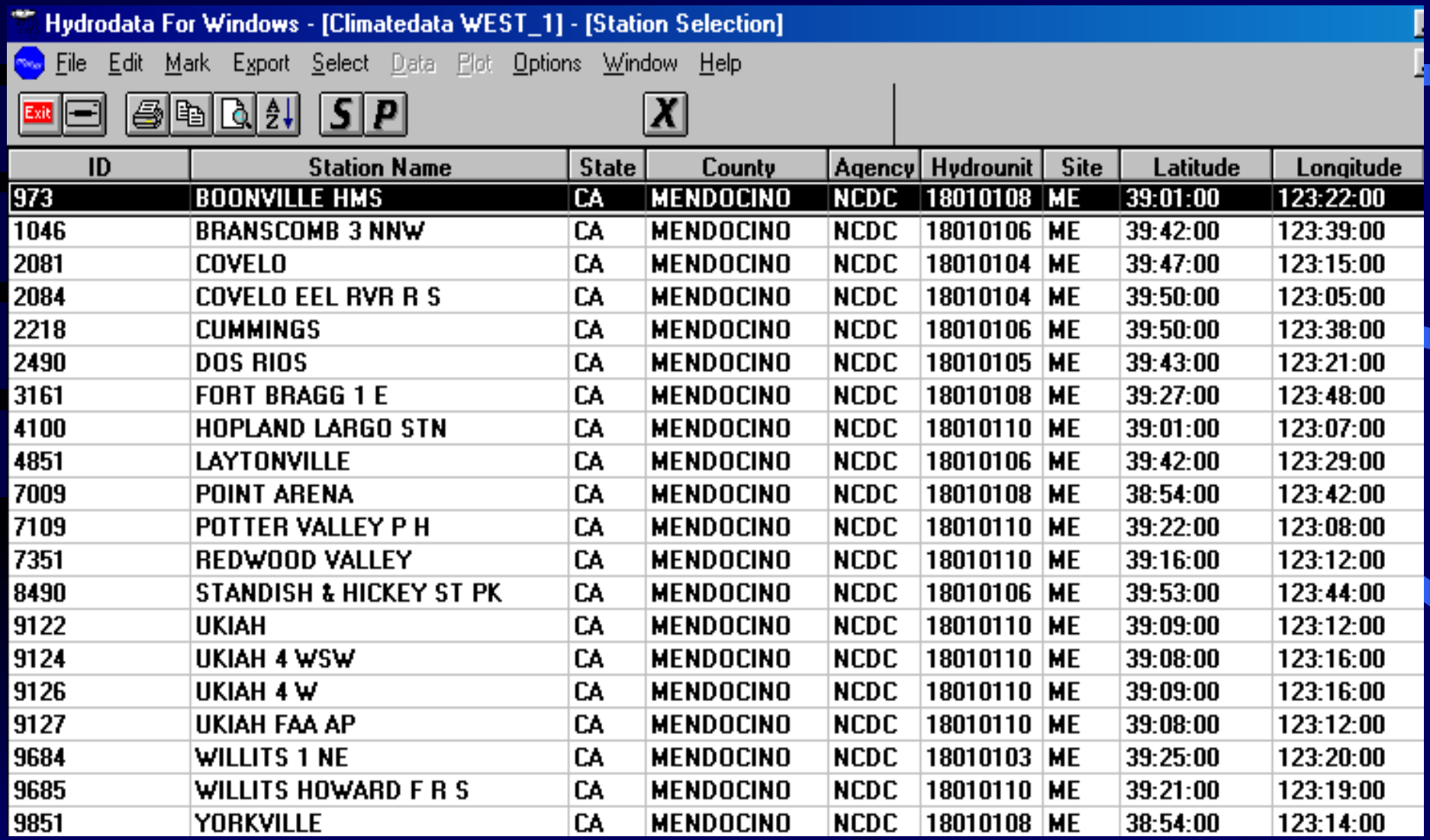
Precipitation Data

- Streamflow may be unavailable or sparse
- Difficult to find good precipitation data
- Variability in rainfall w/ geography
- Large source of error

Precipitation Data

- HydroSphere CD's compiled from National Climate Data Center (NCDC)
  - daily
  - monthly
  - yearly
- WWW.HYDROSPHERE.COM/HDP

Hydrosphere CD - All Precipitation Stations in Mendocino County



ID	Station Name	State	County	Agency	Hydrounit	Site	Latitude	Longitude
973	BOONVILLE HMS	CA	MENDOCINO	NCDC	18010108	ME	39:01:00	123:22:00
1046	BRANSCOMB 3 NNW	CA	MENDOCINO	NCDC	18010106	ME	39:42:00	123:39:00
2081	COVELO	CA	MENDOCINO	NCDC	18010104	ME	39:47:00	123:15:00
2084	COVELO EEL RVR R S	CA	MENDOCINO	NCDC	18010104	ME	39:50:00	123:05:00
2218	CUMMINGS	CA	MENDOCINO	NCDC	18010106	ME	39:50:00	123:38:00
2490	DOS RIOS	CA	MENDOCINO	NCDC	18010105	ME	39:43:00	123:21:00
3161	FORT BRAGG 1 E	CA	MENDOCINO	NCDC	18010108	ME	39:27:00	123:48:00
4100	HOPLAND LARGO STN	CA	MENDOCINO	NCDC	18010110	ME	39:01:00	123:07:00
4851	LAYTONVILLE	CA	MENDOCINO	NCDC	18010106	ME	39:42:00	123:29:00
7009	POINT ARENA	CA	MENDOCINO	NCDC	18010108	ME	38:54:00	123:42:00
7109	POTTER VALLEY P H	CA	MENDOCINO	NCDC	18010110	ME	39:22:00	123:08:00
7351	REDWOOD VALLEY	CA	MENDOCINO	NCDC	18010110	ME	39:16:00	123:12:00
8490	STANDISH & HICKEY ST PK	CA	MENDOCINO	NCDC	18010106	ME	39:53:00	123:44:00
9122	UKIAH	CA	MENDOCINO	NCDC	18010110	ME	39:09:00	123:12:00
9124	UKIAH 4 WSW	CA	MENDOCINO	NCDC	18010110	ME	39:08:00	123:16:00
9126	UKIAH 4 W	CA	MENDOCINO	NCDC	18010110	ME	39:09:00	123:16:00
9127	UKIAH FAA AP	CA	MENDOCINO	NCDC	18010110	ME	39:08:00	123:12:00
9684	WILLITS 1 NE	CA	MENDOCINO	NCDC	18010103	ME	39:25:00	123:20:00
9685	WILLITS HOWARD F R S	CA	MENDOCINO	NCDC	18010110	ME	39:21:00	123:19:00
9851	YORKVILLE	CA	MENDOCINO	NCDC	18010108	ME	38:54:00	123:14:00

Using Rainfall Data in an Excel Spreadsheet

Station Name: Branscomb 3 NNW

Lat 39:42:00, Long 123:39:00, Elevation 1460 feet, Period of record 1960-1977, 18 years of record

	1961	1962	1963	1964	1965	1966	Averages
01-Jan	0.00	0.00	0.00	0.00	0.00	0.13	0.02
02-Jan	0.00	0.00	0.00	0.36	0.23	0.21	0.13
03-Jan	0.00	0.18	0.00	0.00	1.57	2.85	0.77
29-Dec	0.00	0.00	0.08	0.68	2.03	0.00	0.47
30-Dec	0.00	0.00	0.00	0.71	0.76	0.00	0.25
31-Dec	0.00	0.45	0.00	0.38	1.02	0.00	0.31
					Avg calendar yr (in)		**83**
					Avg Dec 15 - Mar 31 (in)		**48**
					Avg Oct 1 - Mar 31 (in)		**73**

Streamflow Data

- USGS is main source of streamflow data
- Discontinued gaging stations w/ short records
- Watershed above gage may be impaired from diversions - hard to estimate unimpaired flow
- Gage usually not located where you need the flow data, especially for “minor” projects
  - “Minor” - less than or equal to 200 acre-feet by storage or less than or equal to 3 cubic feet per second direct diversion

Streamflow Data Sources

- Hydrosphere CD's
  - WWW.HYDROSPHERE.COM/HDP
  - Historical daily USGS gage data
- USGS Website
  - WATER.USGS.GOV/NWIS
  - Historical & provisional real-time data
- CDEC Website
  - CDEC.WATER.CA.GOV
  - Historical & Provisional real-time data

Hydrosphere CD - All Streamflow Stations in Mendocino County

Hydrodata For Windows - [Hydrodata WEST_1] - [Station Selection]

File Edit Mark Export Select Data Plot Options Window Help

ID	Station Name	State	County	Agency	Hydrounit	Site	Latitude	Longitude
11460940	RUSSIAN R NR REDWOOD VALLE	CA	MENDOCINO	USGS	18010110	SW	39:19:10	123:13:20
11461000	RUSSIAN R NR UKIAH CA	CA	MENDOCINO	USGS	18010110	SW	39:11:44	123:11:38
11461400	EF RUSSIAN R TRIB NR POTTER	CA	MENDOCINO	USGS	18010110	SW	39:15:40	123:06:55
11461500	EF RUSSIAN R NR CALPELLA CA	CA	MENDOCINO	USGS	18010110	SW	39:14:48	123:07:45
11461501	EF RUSSIAN R AND POTTER VAL	CA	MENDOCINO	USGS	18010110	SW	39:14:48	123:07:45
11461800	LK MENDOCINO NR UKIAH CA	CA	MENDOCINO	USGS	18010110	LK	39:11:53	123:10:50
11462000	EF RUSSIAN R NR UKIAH CA	CA	MENDOCINO	USGS	18010110	SW	39:11:51	123:11:11
11462500	RUSSIAN R NR HOPLAND CA	CA	MENDOCINO	USGS	18010110	SW	39:01:36	123:07:46
11462668	UNNAMED TRB 1 TO MCDOWELL	CA	MENDOCINO	USGS	18010110	SW	38:58:40	123:03:44
11462700	FELIZ C NR HOPLAND CA	CA	MENDOCINO	USGS	18010110	SW	38:58:20	123:08:30
11463000	RUSSIAN R NR CLOVERDALE CA	CA	MENDOCINO	USGS	18010110	SW	38:52:46	123:03:09
11464050	DRY C TRIB NR HOPLAND CA	CA	MENDOCINO	USGS	18010110	SW	38:53:10	123:09:15
11467600	GARCIA R NR POINT ARENA CA	CA	MENDOCINO	USGS	18010108	SW	38:55:35	123:37:45
11467800	RANCHERIA C NR BOONVILLE CA	CA	MENDOCINO	USGS	18010108	SW	38:59:35	123:26:00
11467850	SODA C TRIB NR BOONVILLE CA	CA	MENDOCINO	USGS	18010108	SW	39:01:32	123:17:25
11468000	NAVARRO R NR NAVARRO CA	CA	MENDOCINO	USGS	18010108	SW	39:10:20	123:40:06
11468010	ALBION R NR COMPTCHE CA	CA	MENDOCINO	USGS	18010108	SW	39:15:40	123:37:00
11468070	SF BIG R NR COMPTCHE CA	CA	MENDOCINO	USGS	18010108	SW	39:13:47	123:27:53
11468150	WARNER C NR FT BRAGG CA	CA	MENDOCINO	USGS	18010108	SW	39:23:13	123:48:42
11468500	NOYO R NR FORT BRAGG CA	CA	MENDOCINO	USGS	18010108	SW	39:25:42	123:44:12
11468540	PUDDING C NR FORT BRAGG CA	CA	MENDOCINO	USGS	18010108	SW	39:27:25	123:43:20
11468600	MF TENMILE R NR FORT BRAGG	CA	MENDOCINO	USGS	18010108	SW	39:34:22	123:41:57
11468850	DUNN C NR ROCKPORT CA	CA	MENDOCINO	USGS	18010108	SW	39:47:56	123:49:11
11469800	COLD C TRIB NR ELK C CA	CA	MENDOCINO	USGS	18010103	SW	39:26:18	122:45:35

Using Streamflow Data

South Fork Eel River near Branscomb (11475500)						
	1947	1948	1949	1950		
01-Oct	2.60	1.90	7.50	2.40		
02-Oct	2.60	2	7.50	2.40		
29-Sep	2	7.50	2.20	1.90		
30-Sep	1.90	7.50	2.20	1.90		
					Average (AF)	
Yrly total (AF)	53,708	106,223	101,056	95,793	124,806	
12/15-3/31 (AF)	35,385	57,941	75,242	81,829	90,652	73%
10/1 - 3/31 (AF)	43,799	67,696	94,262	83,323	108,196	87%

108,196 AF / 124,806 AF = 87%

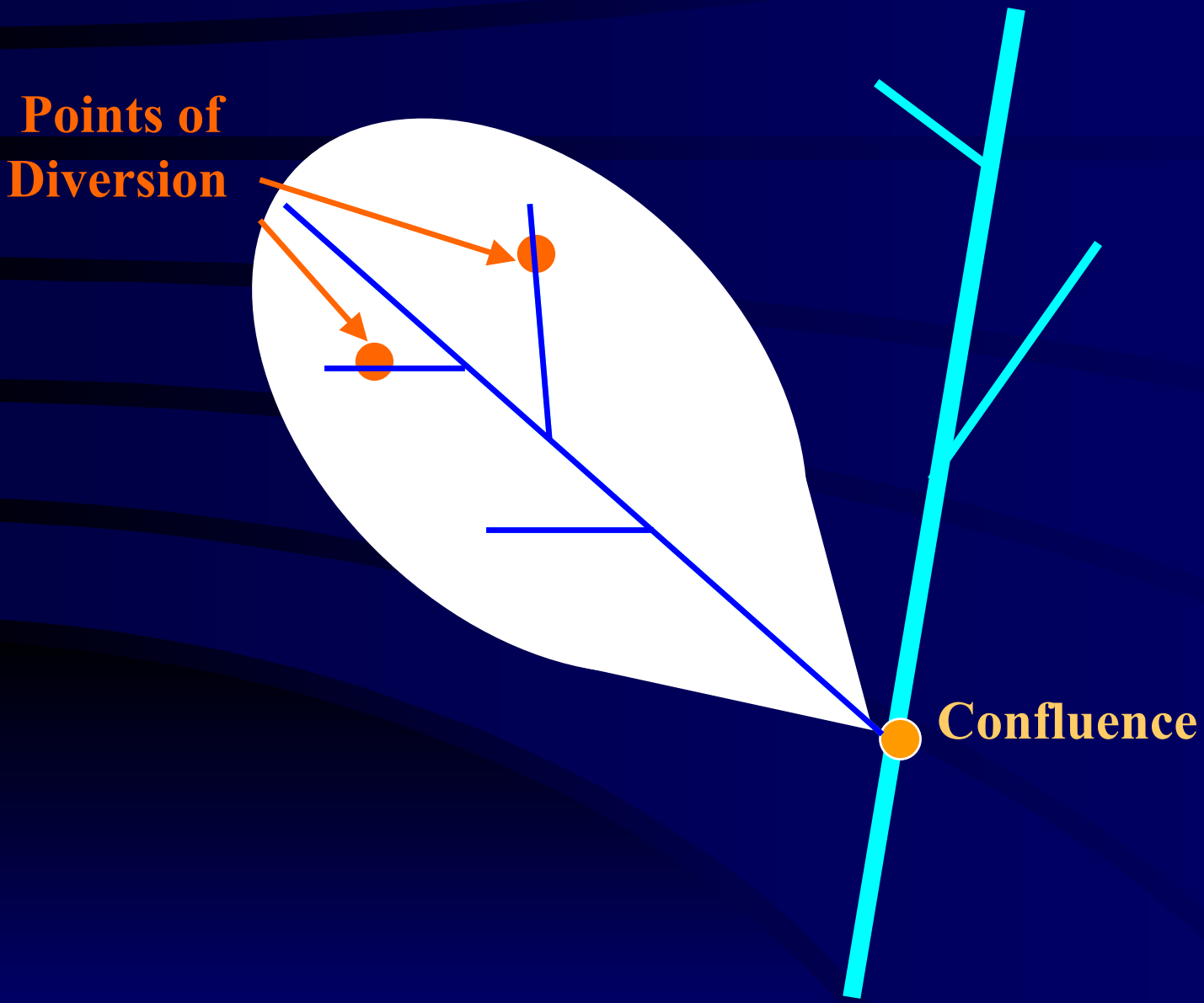
On avg, 87% of streamflow occurs between Oct 1 and Mar 31

Evaluating Projects: Points of Interest

- NMFS and DFG are providing the location of points of interest for "coastal" watersheds based on their fishery resources information

- Examples of Points of Interest
  - A project's point of diversion
  - Where flow needs to be maintained for fishery resources (spawning, rearing, passage)

Points of Interest Schematic



Cumulative Flow Impairment Index (CFII)

- Estimated at a Point of Interest
- Ratio of Demand to Supply
  - Used to determine the relative impairment of a watershed

Cumulative Flow Impairment Index (CFII)

- Estimate on annual or seasonal basis.
- For certain "North Coast" watersheds in the Counties of Mendocino, Sonoma, Marin and Napa, a season of Oct 1 to Mar 31 is used *.
  - October 1 - Beginning of water year when reservoirs start to fill.
  - March 31 - end of spawning, incubation, and outmigration period for anadromous fish **

*** Since the May 1, 2003 workshop, NMFS has recommended a season of October 1 to March 31 for demand and December 15 to March 31 for supply**

*** * 1997 SWRCB Russian River Division Staff Report**

Estimating Water Demand

- Use SWRCB's Water Right Information Management System (WRIMS) Database
- Use maximum diversion or storage (face value) listed in WRIMS of all known water rights above point(s) of interest
- Download / verify WRIMS data by cross-referencing with (paper) water right files
- If necessary, estimate seasonal demand from annual demand listed in WRIMS database

Water Rights Included in Demand

- Statements of Water Diversion and Use for "Riparian" and "Pre-1914" Appropriators
- Existing "Post-1914" water right applications
- Small Domestic Registrations
- Stockwatering Certificates
- Small Livestock Registration
- Other known authorized diversions
- **Pending water right applications**

Demand Assumptions

- Use maximum diversion and/or storage amount specified in Application or Permit until License is issued
- Storage: Include domestic, irrigation, stockwatering, recreation, fish & wildlife uses, but not power
- Direct Diversion: Include 10 days frost protection; do not include direct diversion for irrigation or power

Estimating Demand

- Problem: The storage or direct diversion season is year-round or partially within the season of interest

- Approach: Prorate the year-round or seasonal use to the season of interest, equally dividing the total use into the appropriate number of months, unless more detailed water use information is known

Estimating Demand

- Problem: There is more than one pending application in the watershed above the point of interest

- Approach: Estimate the demand for each pending application in the order of the application's priority

Estimating Supply

- Watershed-specific models: Russian River SSM (Streamflow Simulation Model)
  - Weekly
  - HEC-1 (Rainfall-Runoff) based
- Rainfall - Runoff method
  - Adaptation of the Rational Method
  - Used to estimate average annual flow
- Area-ratio streamflow method

Rainfall / Runoff Method

- $Q = c\ I\ A$
  - c = runoff coefficient
  - I = precipitation (feet)
  - A = watershed area above point of interest (acres)
  - Q = runoff (acre-feet)

Rainfall-Runoff Method
Step 1: Find Runoff Coefficient (c)

- Based on:
  - Relief
  - Soil type
  - Vegetal cover
  - Surface storage
- Assign a value to each of the four categories above based on the Runoff Coefficient Table and sum them to get the runoff coefficient

Runoff Coefficient Table: Caltrans Highway Design Manual, 1995

	Watershed Types			
	Extreme	High	Normal	Low
Relief	0.28 – 0.35 Steep, rugged terrain with average slopes above 30%	0.20 – 0.28 Hilly, with average slopes of 10 to 30%	0.14 – 0.20 Rolling with average slope of 5 to 10%	0.08 – 0.14 Relatively flat land, with average slope of 0 to 5%
Soil Saturation	0.12 – 0.16 No effective soil cover; either rock or thin soil mantle of negligible infiltration capacity	0.08 – 0.12 Slow to take up water; clay or loam soil of low infiltration capacity; imperfectly or poorly drained	0.06 – 0.08 Normal; well-drained, high or medium-textured soils, sandy loams, silt and silty loams.	0.04 – 0.06 High; deep sand or other soil that takes up water readily, very high level drained soils.
Vegetal Cover	0.12 – 0.16 No effective plant cover, bare, or very sparse cover	0.08 – 0.12 Poor to fair; clean cultivation crops, or poor natural cover, less than 20% of drainage area over good cover	0.06 – 0.08 Fair to good; about 50% of area in good grassland or woodland, not more than 50% of area in cultivated crops	0.04 – 0.06 Good to excellent; about 90% of drainage area in good grassland, woodland or equivalent cover
Surface Storage	0.10 – 0.12 Negligible surface depression few and shallow; drainage ways steep and small, no marshes	0.08 – 0.10 Low; very well defined system of drainage ways; no ponds or marshes	0.06 – 0.08 Normal; considerable surface depression storage, lakes and pond marshes	0.04 – 0.06 High; surface storage high; drainage system not sharply defined, large floodplain storage or large number of pond

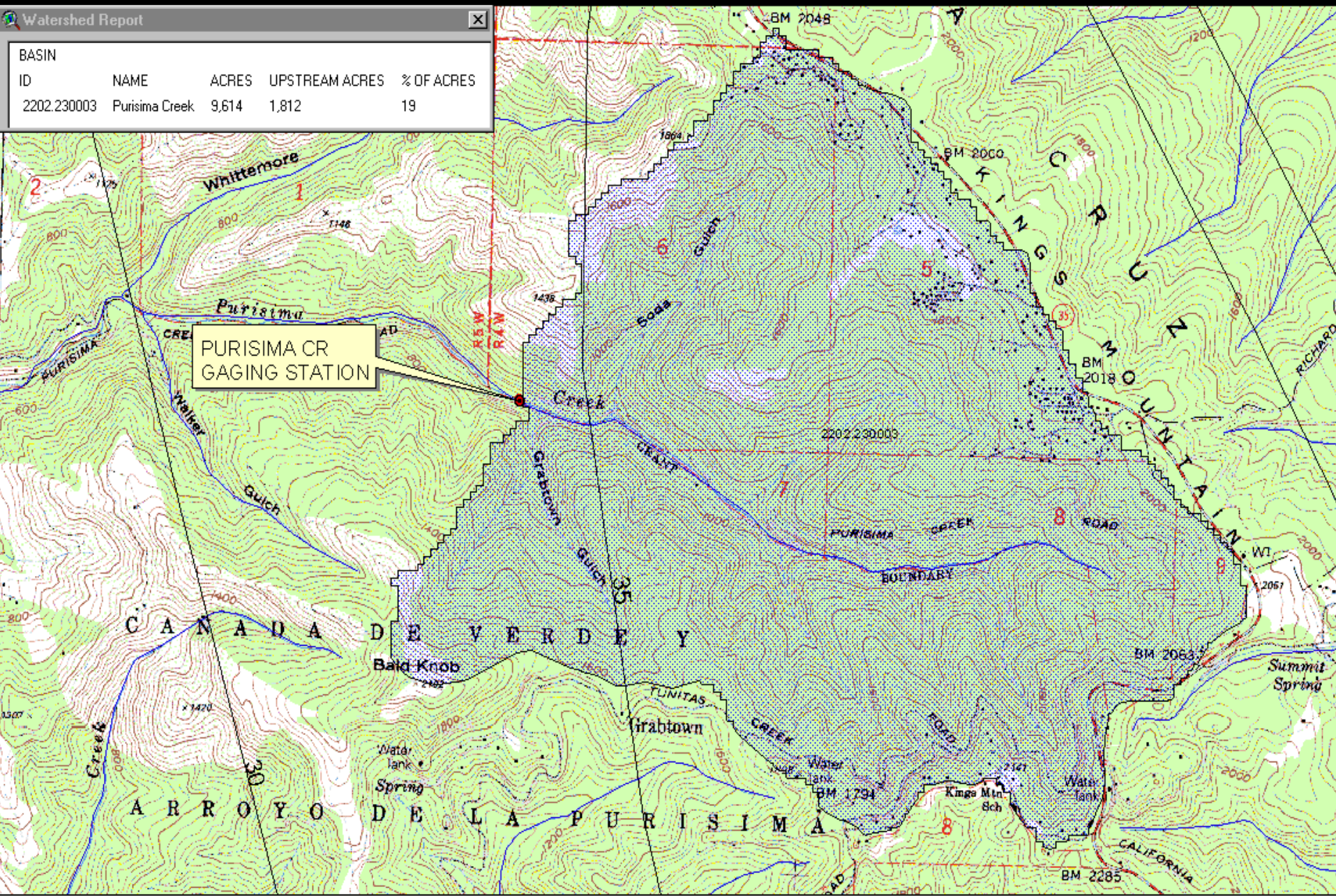
Rainfall-Runoff Method
Step 2: Estimate Precipitation, I

- Method 1: Use Precipitation Gage Data Directly
  - Use annual average rain gage data
  - Calculate seasonal rainfall from daily data in Excel spreadsheet
- Method 2: Read Value from Isohyetal Map
  - SCS Soil Report (A report exists for each county)
  - WRIMS GIS rainfall coverage

Rainfall-Runoff Method
Step 3: Estimate Watershed Area, A

- Measure Area Using Planimeter
  - For smaller watershed areas
  - For flat areas (like portions of Napa)
- ArcView GIS
  - Efficient new tool
  - Zoom to appropriate scale
  - GIS cannot always find watershed boundary

Watershed Area using GIS



Rainfall -Runoff Example: Estimate Average Annual Runoff

- C = 0.50
- I = 48 in/yr = 4 ft/yr
- A = 300 acres (area above point of interest)
- Q = c * I * A = 0.50 * (4 ft/yr) * (300 acres)
- Q = 600 acre-feet per year

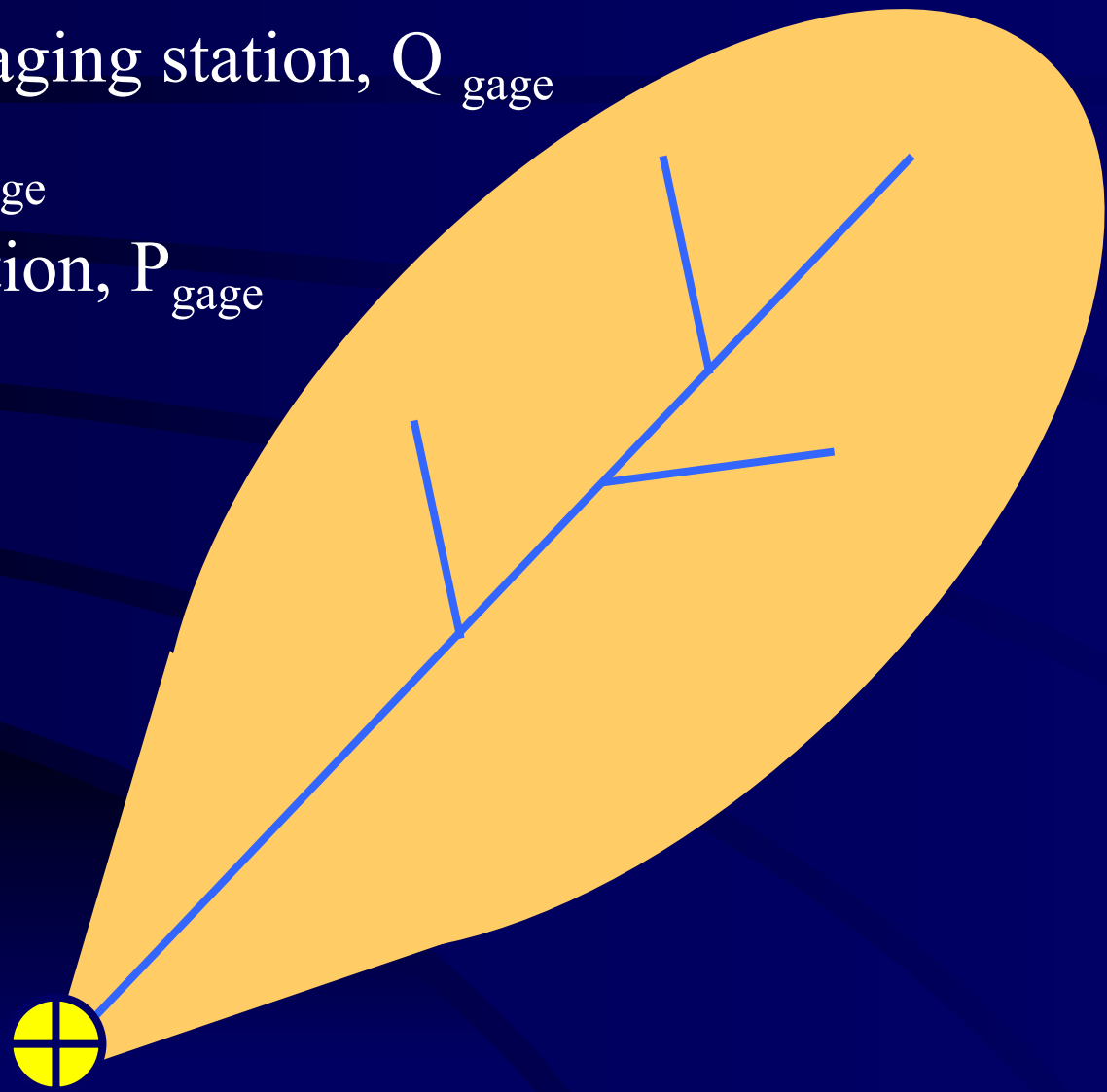
- To estimate seasonal flow from annual flow, multiply the annual flow by the % of flow that occurs in the season.

Area-Ratio Streamflow Method

- $Q = Q_{gage} * (A/A_{gage}) * (P/P_{gage})$
  - Q is the unknown flow at a point of interest
  - Q_{gage} is the flow measured at the streamgage
  - A is the area above the point of interest
  - A_{gage} is the area above the streamgage
  - P_{gage} is the precipitation above the streamgage
  - P is the precipitation above the point of interest

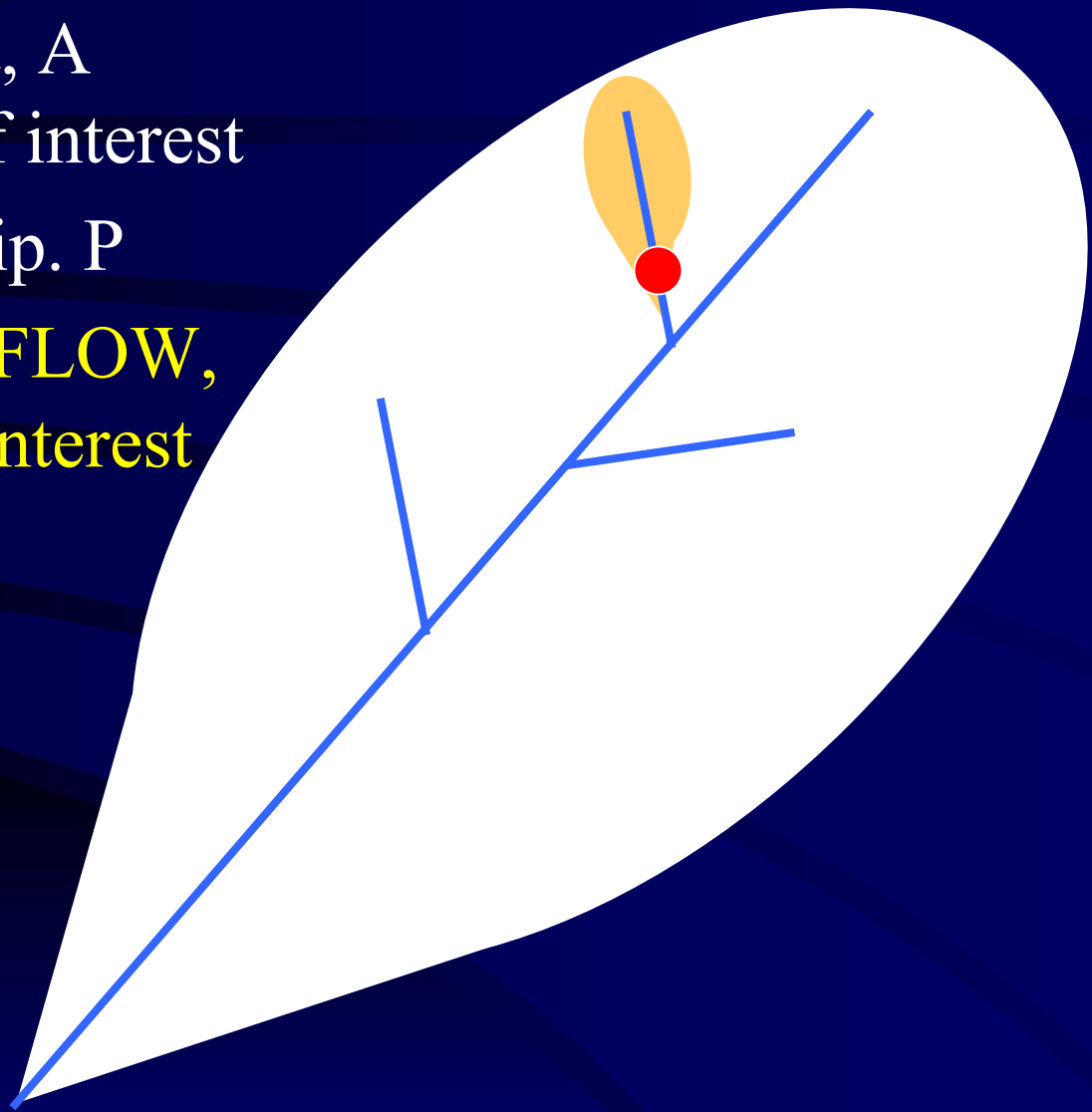
Area-Ratio Streamflow Method

- Known flow at gaging station, Q_{gage}
- Known Area, A_{gage}
- Known Precipitation, P_{gage}



Area-Ratio Streamflow Method

- Estimate Area, A above point of interest
- Estimate Precip. P
- UNKNOWN FLOW, Q at point of interest



Estimating Bypass Flow

- Instantaneous flow rate to be maintained past a project's point of diversion
- To protect fish habitat
- To provide appropriate contributions to fish habitat downstream
- Determined on a case-by-case basis

February Median Flow

- NMFS, DFG and Division staff have recommended that a bypass equal to the February median flow be used in "North Coastal" watersheds
  - Mendocino County
  - Sonoma County
  - Marin County
  - Napa County

Estimating February Median Flow

- The Median is the "middle value" of a set of data, not the average
- Estimated using daily streamflow data

Estimating Flow: Limitations

- Flow prediction difficult - small watersheds, intermittent streams, sparse hydrologic data
- Lack of streamflow data suggests a regional regression approach

Evaluating and Improving Methodology

- MBK Engineers peer reviewed SWRCB's use of Q = CIA to estimate average annual flow
- Current USGS contract work - evaluating SWRCB flow estimation in North Coast Region
- Future USGS contract work - develop regional regression equations to estimate flow statistics

The End