RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

2018 Sacramento River Temperature Management: Stakeholder Workshop

April 25, 2018 1:00 pm – 3:00 pm

Location: Mid-Pacific Regional Office, 2800 Cottage Way, Sacramento

Room: Conference Room W-2617

Conference Line: 1-415-527-5035

Participant code: 904 194 917 (Password: 7JYH4PS3)

Browser Connection: Click Here

Purpose:

Reclamation is providing a forum where data, information, science/technology, and ideas related to developing the 2018 Sacramento River Temperature Management Plan will be shared. Reclamation is soliciting feedback to be considered in the current water year temperature management efforts to provide suitable temperatures for the protection of fish species/habitat below Shasta Dam in the Sacramento River.

Agenda:

1. Introductions (Reclamation)
2. Overview of Current Conditions (Reclamation)
    a. Operations Outlook
    b. Brief Temperature Management Criteria Overview
    c. Brief Temperature Control Device Overview
    d. Preliminary Temperature Management Scenario
3. Open Discussion: Considerations for 2018 Temperature Management (All)
4. Re-Cap of Considerations and Adjourn (Reclamation)

Please notify Reclamation in advance to coordinate audio/visual needs if necessary.

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2018 Sacramento River Temperature Management: Stakeholder Workshop

Central Valley Operations Office

April 25, 2018

U.S. Department of the Interior
Bureau of Reclamation

Agenda

1. Introductions
2. Overview of Current Conditions
   - Operation Outlook
   - Temperature Management Criteria
   - Temperature Control Device
   - Preliminary Temperature Mgmt. Scenarios
3. Open Discussion: Considerations for 2018 Temperature Management
4. Re-Cap of Considerations and Adjourn

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Current Conditions

- Shasta Lake Storage: 4,199,000 AF
- Keswick Dam Release: 5,750 cfs

- Recent Actions: Orders 4/20 – 4/24 to increase Keswick Dam releases and TCD change
  - –Downstream demands and temperature management
- Record High Redding Air Temperature 4/24

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Operation Outlook

CVP Northern System Operation Outlook

Draft April 2018

90% Runoff Exceedance Outlook:

Inflow based on the DWR 2018 B120, 70% Historical Inflows Oct and future months

Federal End of the Month Storage/Elevation (TAF/Feet)

		Apr	May	Jun	Jul	Aug	Sep	Oct
Shasta	3880	4132	4011	3656	3077	2630	2351	2226
Elev.		1052	1048	1035	1011	991	977	970

Monthly River Releases (cfs)

Sacramento	5000	8000	10500	13000	10500	8000	6000
Clear Creek	218	216	288	150	150	150	200

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct
Carr Power Plant	39	67	85	80	71	62	16
Spring Creek PP	10	60	70	70	60	60	30

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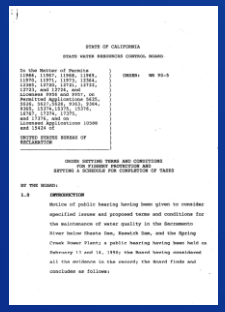
Temperature Management Criteria



STATE OF CALIFORNIA

STATE WATER RESOURCES CONTROL BOARD

In the Matter of Permits
11966, 11967, 11968, 11969,
11970, 11971, 11973, 12364,
12365, 12720, 12721, 12722,
12723, and 12724, and
Licenses 9936 and 9937, on
Permitted Applications 5625,
5626, 5627,5628, 9363, 9364,
9365, 15374,15375, 15376,
16767, 17374, 17375,
and 17376, and on
Licensed Applications 10588
and 15424 of

UNITED STATES BUREAU OF
RECLAMATION

ORDER: WR 90-5

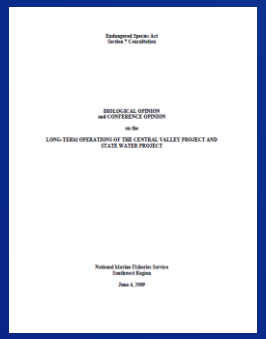
ORDER SETTING TERMS AND CONDITIONS
FOR FISHERY PROTECTION AND
SETTING A SCHEDULE FOR COMPLETION OF TASKS

BY THE BOARD:

1.0 INTRODUCTION

Notice of public hearing having been given to consider specified issues and proposed terms and conditions for the maintenance of water quality in the Sacramento River below Shasta Dam, Keswick Dam, and the Spring Creek Power Plant; a public hearing having been held on February 13 and 14, 1990; the Board having considered all the evidence in the record; the Board finds and concludes as follows:

- **1990 – 1991: SWRCB 90-5 and 91-1**
  - **Operate Shasta, Keswick, Spring Creek Power Plant to meet daily average water temperature of 56°F at Red Bluff Diversion Dam**
  - **Compliance point may be changed when the objective can not be met at Red Bluff Diversion Dam**



Endangered Species Act
Section 7 Consultation

BIOLOGICAL OPINION
and CONFERENCE OPINION

on the

LONG-TERM OPERATIONS OF THE CENTRAL VALLEY PROJECT AND
STATE WATER PROJECT

National Marine Fisheries Service
Southwest Region

June 4, 2009

- **2009: NMFS Biological Opinion: RPA Action**
  - **Spring Action: 56°F daily average between Balls Ferry and Bend Bridge Apr 15 – May 15**
  - **Summer Action: 56°F daily average between Balls Ferry and Bend Bridge May 15 – Oct 31**
  - **Exceptions: Under Critical Conditions**

Sac River Temperature Task Group

CALIFORNIA WATER BOARDS
State Water Resources Control Board

U. S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

CALIFORNIA DEPARTMENT OF FISH & WILDLIFE
California Department of Fish and Wildlife

NOAA FISHERIES
National Oceanic and Atmospheric Administration

THE GREAT SEAL OF THE HOOPA VALLEY TRIBE

THE YUROK TRIBE

Western Area Power Administration

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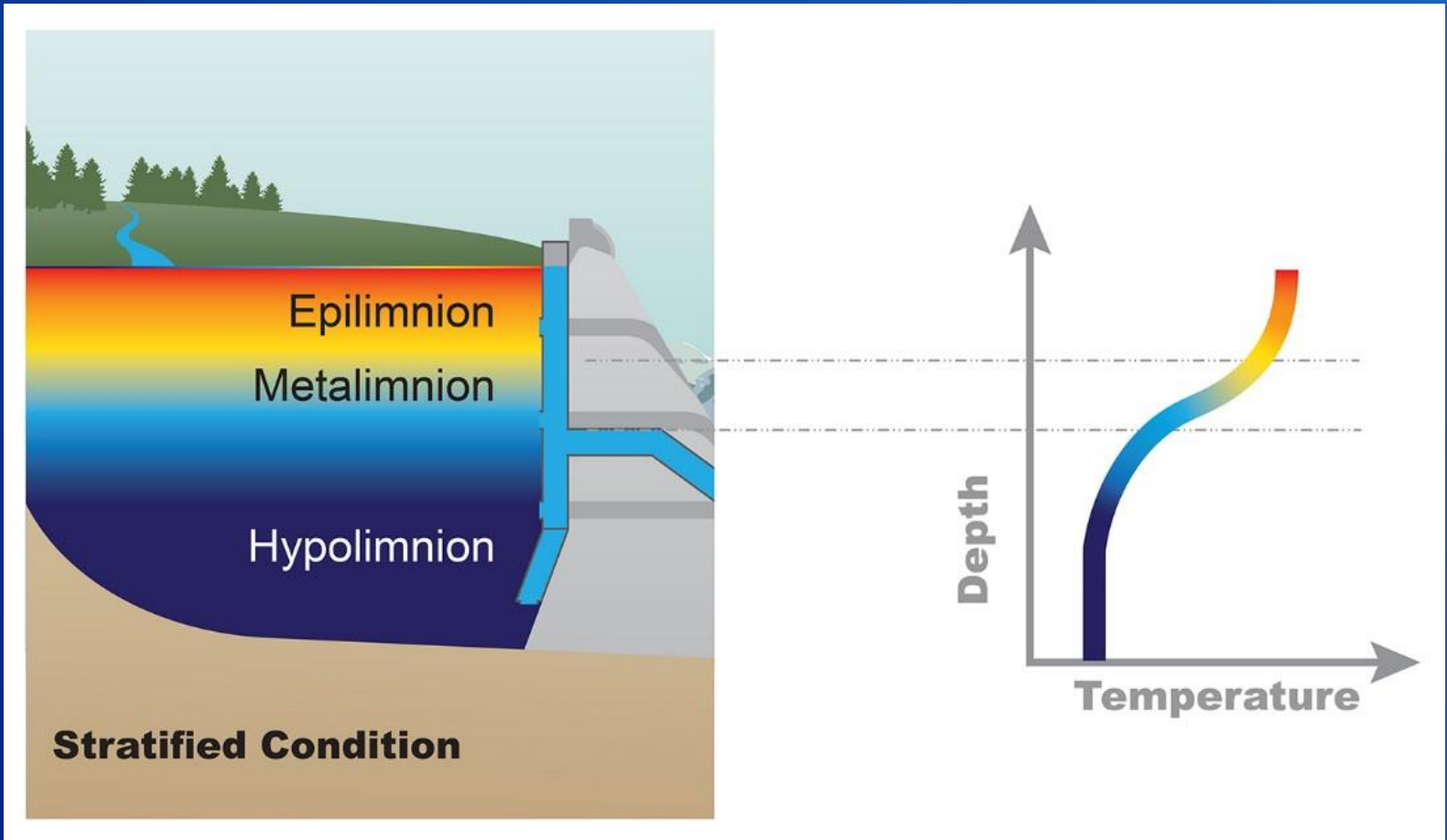
Temperature Management Dynamics

Lake Stratification



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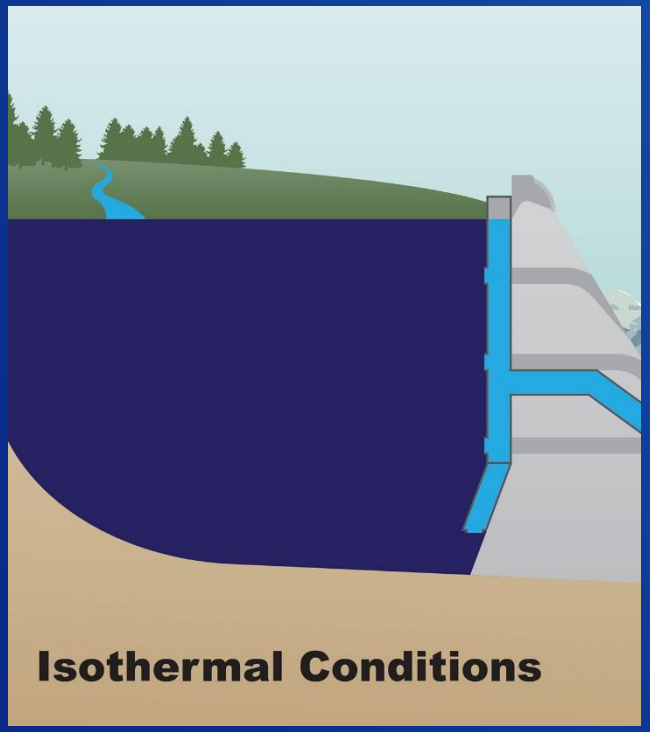
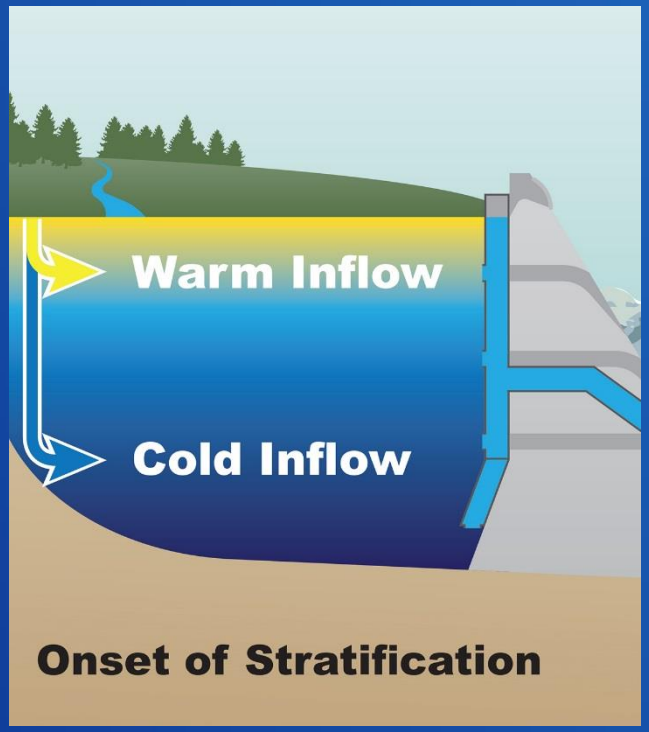
Seasonal Lake Characteristics

Winter



Spring



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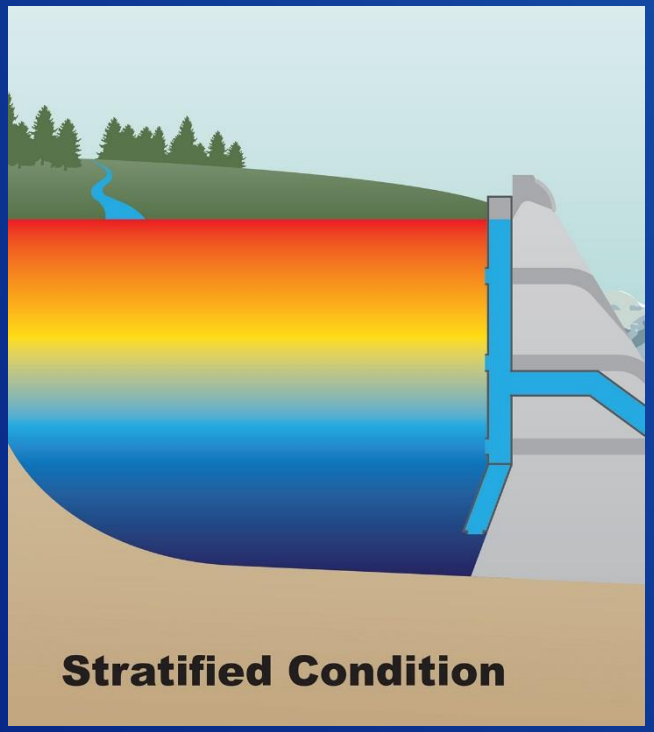
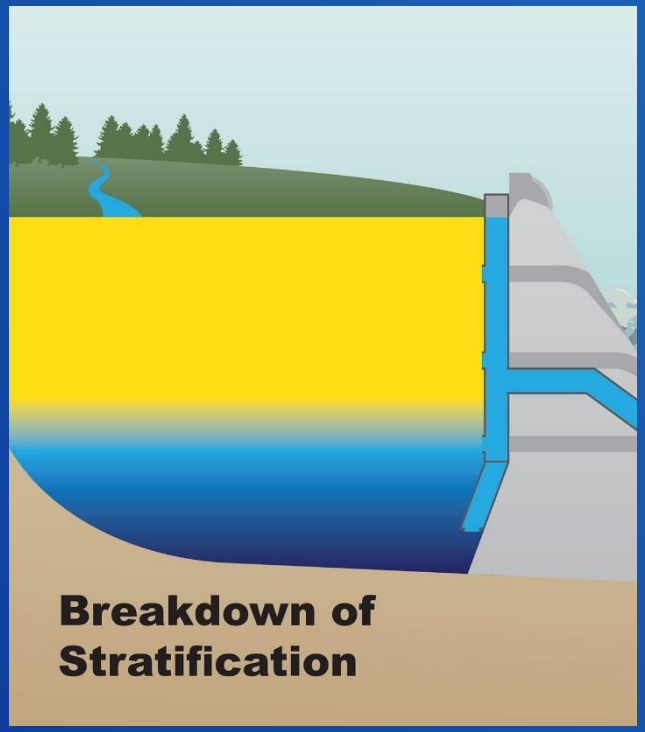
Seasonal Lake Characteristics

Summer



Fall



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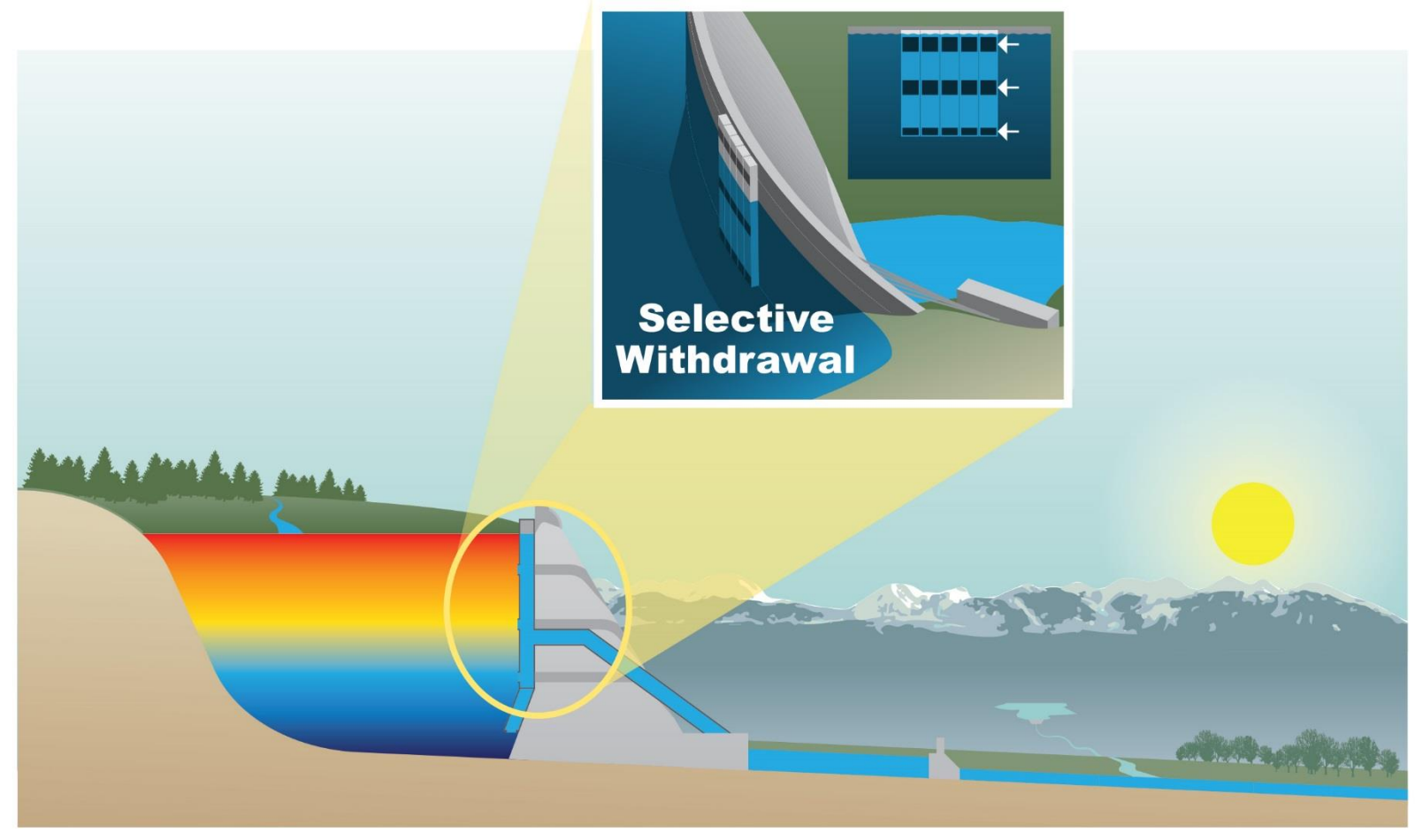
Temperature Control Device System



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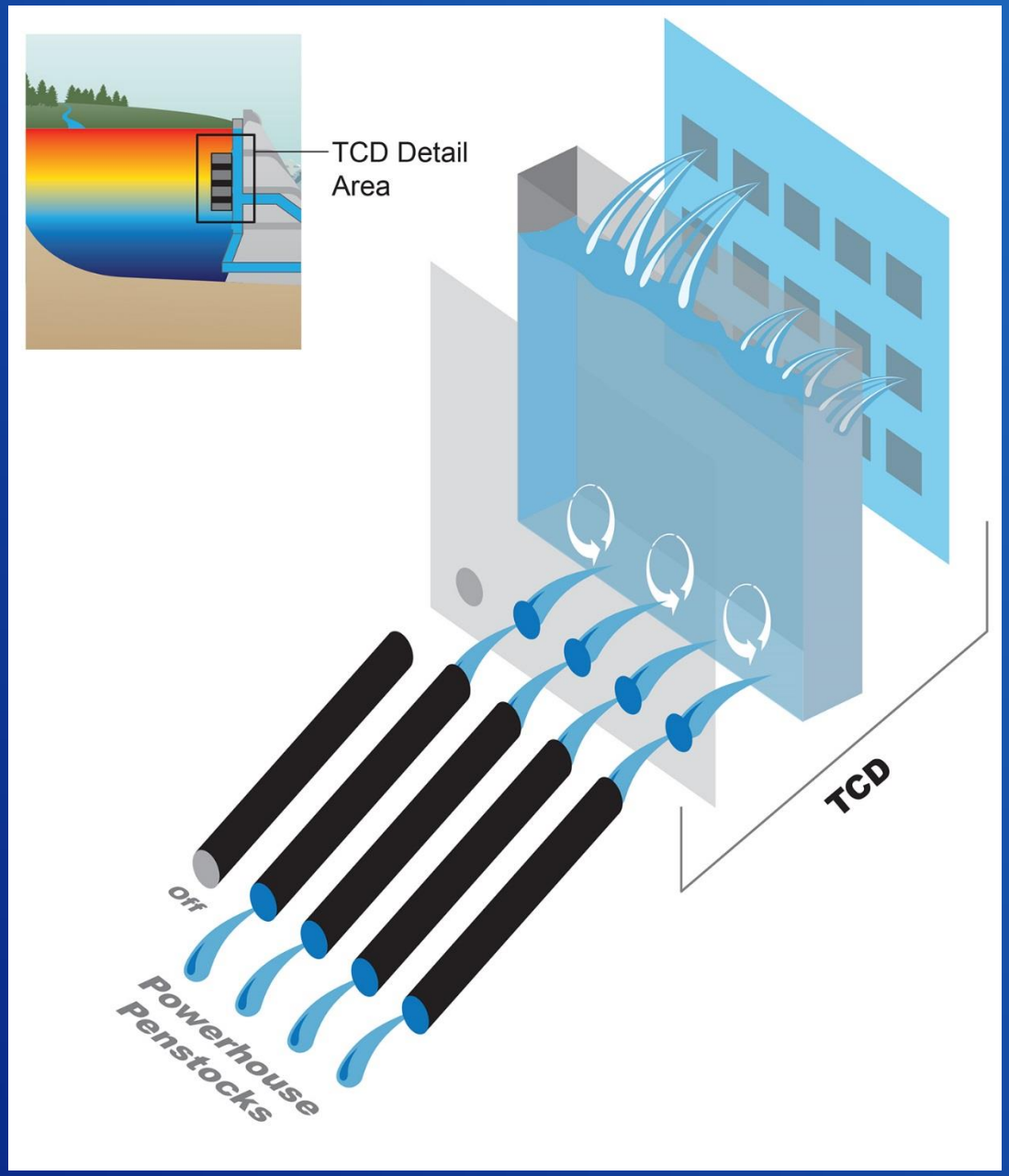
TCD



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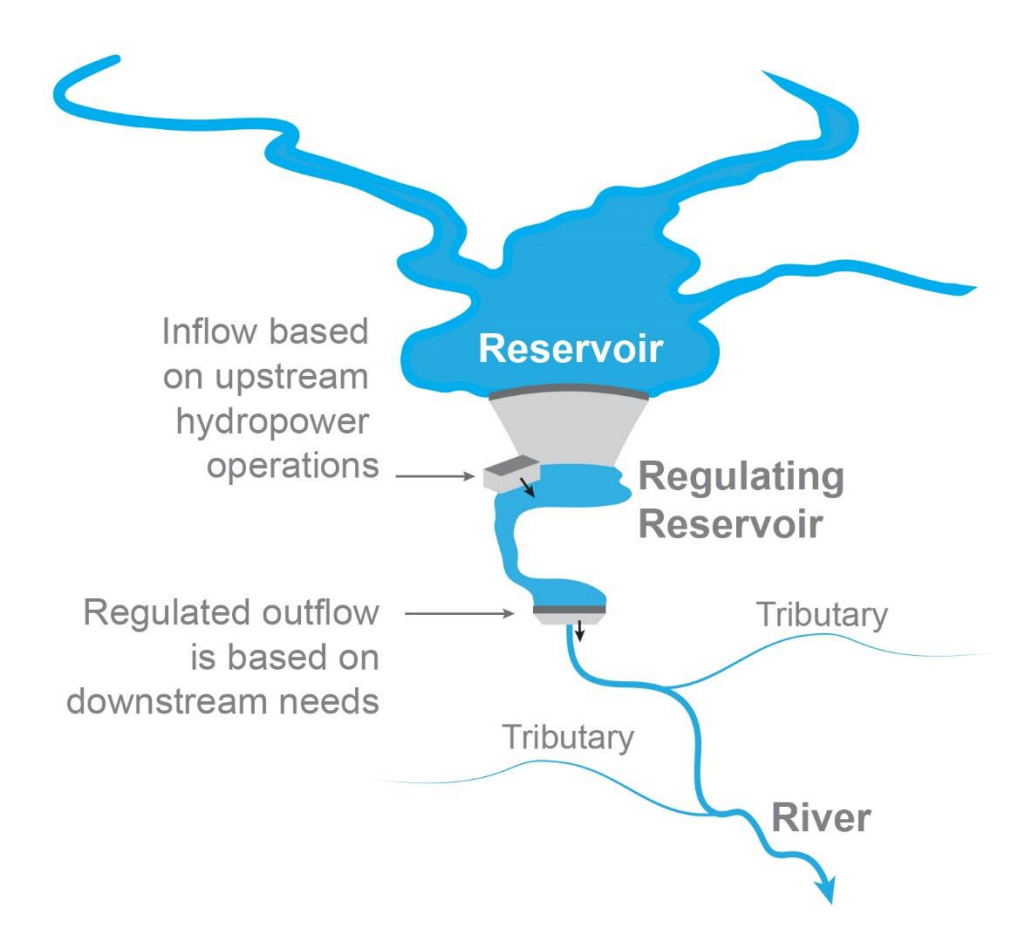
Reservoir and Regulating Reservoir



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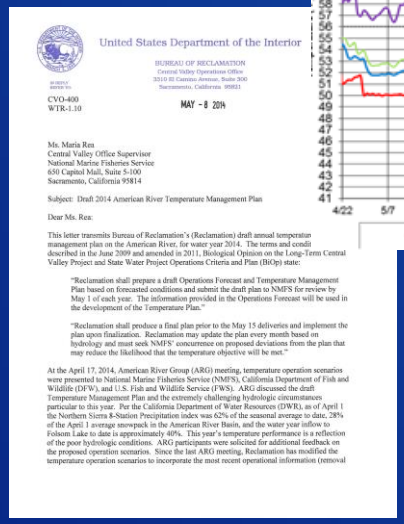
Temperature Management Process



United States Department of the Interior

BUREAU OF RECLAMATION
Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

CVO-400
WTR-1.10

MAY - 8 2014

Ms. Maria Rea
Central Valley Office Supervisor
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

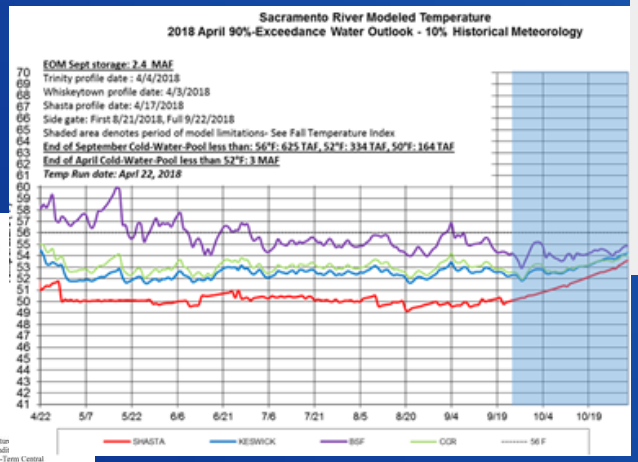
Subject: Draft 2014 American River Temperature Management Plan

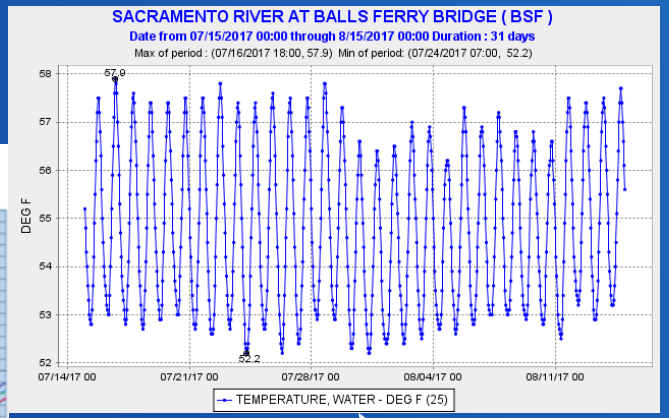
Dear Ms. Rea:

This letter transmits Bureau of Reclamation's (Reclamation) draft annual temperatur management plan on the American River, for water year 2014. The terms and condi described in the June 2009 and amended in 2011, Biological Opinion on the Long-Term Central Valley Project and State Water Project Operations Criteria and Plan (BiOp) state:

> "Reclamation shall prepare a draft Operations Forecast and Temperature Management Plan based on forecasted conditions and submit the draft plan to NMFS for review by May 1 of each year. The information provided in the Operations Forecast will be used in the development of the Temperature Plan."
>
> "Reclamation shall produce a final plan prior to the May 15 deliveries and implement the plan upon finalization. Reclamation may update the plan every month based on hydrology and must seek NMFS' concurrence on proposed deviations from the plan that may reduce the likelihood that the temperature objective will be met."

At the April 17, 2014, American River Group (ARG) meeting, temperature operation scenarios were presented to National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (DFW), and U.S. Fish and Wildlife Service (FWS). ARG discussed the draft Temperature Management Plan and the extremely challenging hydrologic circumstances particular to this year. Per the California Department of Water Resources (DWR), as of April 1 the Northern Sierra 8-Station Precipitation index was 62% of the seasonal average to date, 28% of the April 1 average snowpack in the American River Basin, and the water year inflow to Folsom Lake to date is approximately 40%. This year's temperature performance is a reflection of the poor hydrologic conditions. ARG participants were solicited for additional feedback on the proposed operation scenarios. Since the last ARG meeting, Reclamation has modified the temperature operation scenarios to incorporate the most recent operational information (removal





1. May: Temperature Management Plan

2. Update Plan Monthly

3. November: Complete Season

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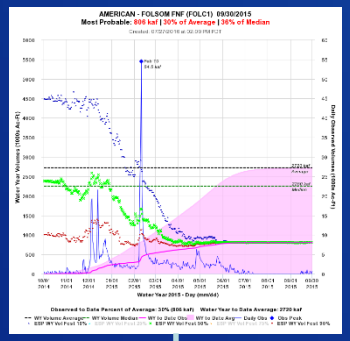
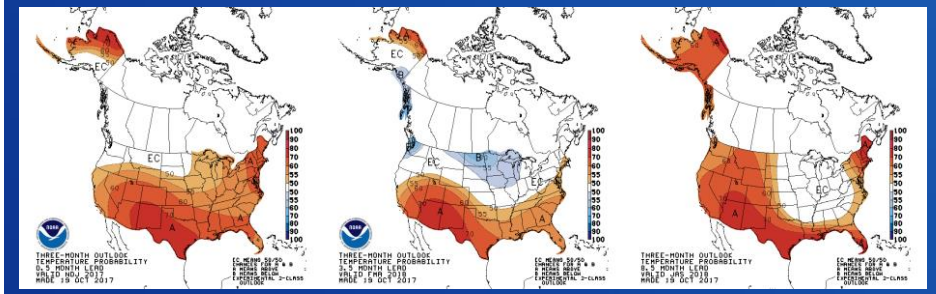
Temperature Modeling – Seasonal Plan

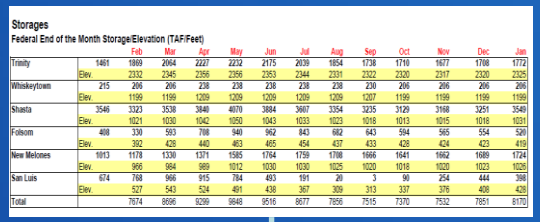
Hydrology Forecasts



Long-Term Meteorology Forecasts



Operation Outlook

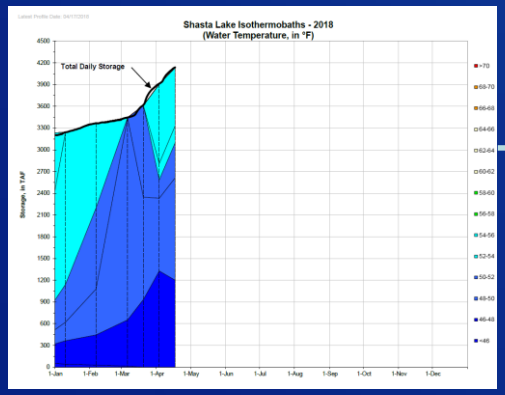


Storages

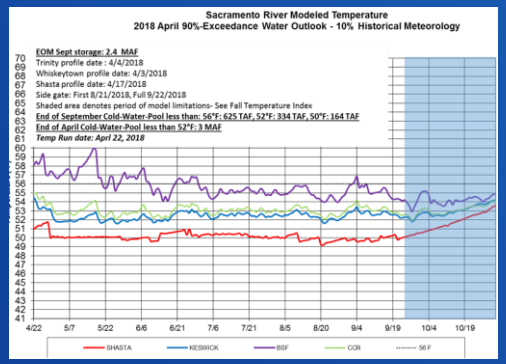
Federal End of the Month Storage/Elevation (TAF/Feet)

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Trinity		1461	1869	2064	2227	2232	2175	2039	1854	1738	1710	1677	1708	1772
	Elev.		2332	2345	2356	2356	2353	2344	2331	2322	2320	2317	2320	2325
Whiskeytown		215	266	266	238	238	238	238	238	230	206	206	206	206
	Elev.		1199	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199
Shasta		3546	3323	3538	3840	4070	3884	3667	3354	3235	3129	3168	3251	3549
	Elev.		1021	1030	1042	1050	1043	1033	1023	1018	1013	1015	1018	1031
Folsom		408	330	593	708	940	962	843	682	643	594	565	554	520
	Elev.		392	428	440	463	465	454	437	433	428	424	423	419
New Melones		1013	1178	1338	1371	1585	1764	1759	1708	1666	1641	1662	1689	1724
	Elev.		966	984	989	1012	1030	1030	1025	1020	1018	1020	1023	1026
San Luis		674	768	966	915	784	493	191	20	3	90	254	444	398
	Elev.		527	543	524	491	438	367	309	313	337	376	408	428
Total			7674	8696	9299	9848	9516	8677	7856	7515	7370	7532	7851	8170

Initial Conditions



Temperature Performance



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Preliminary Temperature Management Scenarios

Summary of Temperature Results by Month (Monthly Ave. Temp. °F)

Initial Compliance Location (°F DAT)	ARR	MAY	JUN	JUL	AUG	SEP	OCT	Late Sep-Oct Uncertainty Estimation
April 90%-Exceedance Outlook – 10% Historical Meteorology								
Keswick Dam KWK	52.6	52.0	52.4	53.0	53.1	53.3	52.2	53 - 56
Sac. R. abv Clear Creek CCR	53.1	52.9	53.1	53.5	53.6	53.7	52.3	54 - 58
Balls Ferry BSF	55.9	57.2	56.1	55.5	55.5	55.5	53.6	55 - 58
April 90%-Exceedance Outlook – 50% Historical Meteorology								
Keswick Dam KWK	52.5	51.9	52.0	53.0	53.0	53.1	52.0	53 - 56
Sac. R. abv Clear Creek CCR	52.9	52.7	52.6	53.4	53.5	53.5	52.1	54 - 58
Balls Ferry BSF	55.5	56.6	55.5	55.3	55.3	55.2	53.2	55 - 58
April 50%-Exceedance Outlook – 10% Historical Meteorology								
Keswick Dam KWK	52.3	51.3	52.0	52.8	53.1	53.3	52.0	53 - 56
Sac. R. abv Clear Creek CCR	52.9	52.1	52.5	53.2	53.4	53.5	52.1	54 - 58
Balls Ferry BSF	55.8	56.7	55.4	55.1	55.2	55.2	53.3	55 - 58
April 50%-Exceedance Outlook – 50% Historical Meteorology								
Keswick Dam KWK	52.2	50.9	52.2	52.8	53.2	53.1	51.8	53 - 56
Sac. R. abv Clear Creek CCR	52.7	51.5	52.6	53.1	53.4	53.3	51.9	53 - 57
Balls Ferry BSF	55.3	55.8	55.3	54.9	55.1	54.9	53.0	54 - 58

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Questions

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Open Discussion: Considerations for 2018 Temperature Management

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Alternative temperature strategy for Shasta Operations

Constant vs. hatch

Jim Anderson
University of Washington

Background

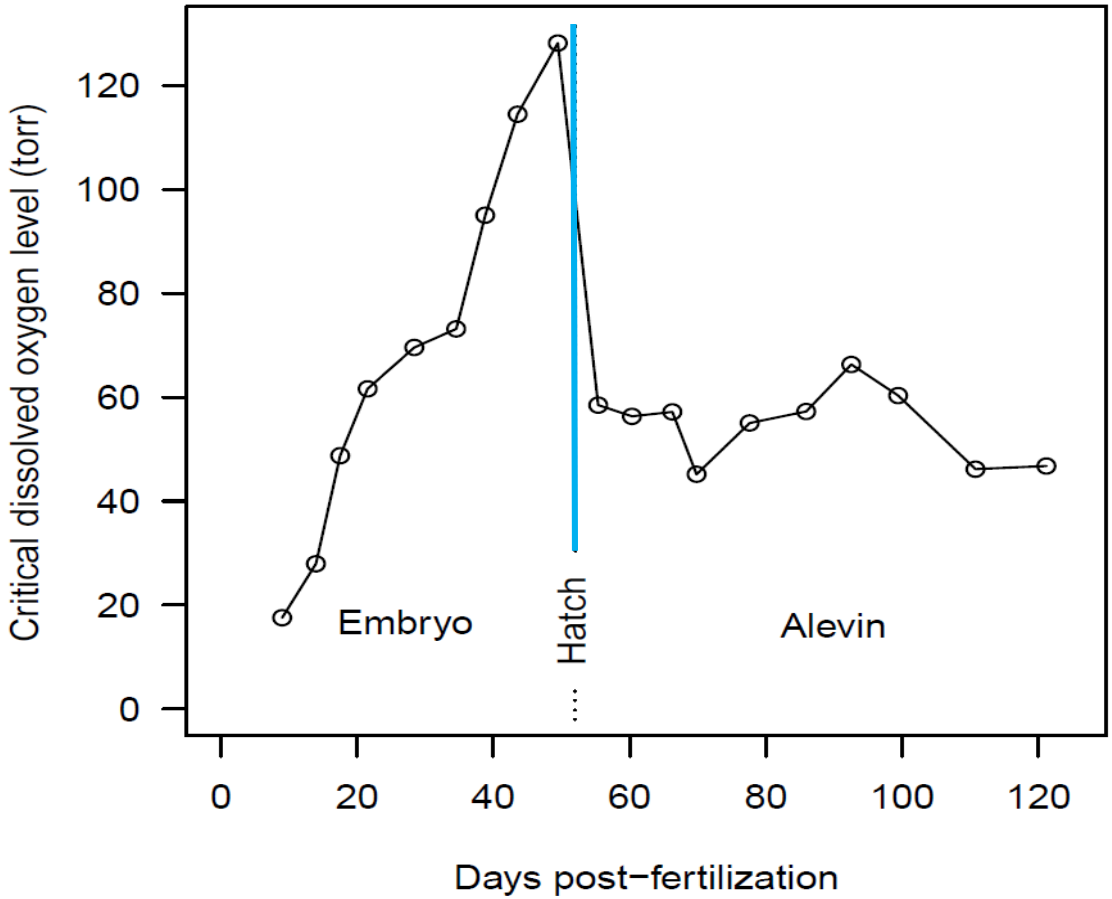
- Ben Martin and colleagues at NOAA (Martin et al. 2017)
- Proposed egg mortality results when metabolic demand exceeds oxygen flux into the redds
- To reduce mortality maintain incubation temperatures at 53.5 ^{o}F

Proposed Additions to the model

- Incorporating fish physiology into the NOAA model (Anderson 2018)
- Shows egg hatch is the most critical stage for oxygen supply, other stages are far less sensitive
- Therefore, targeting cold water to hatch to reduce metabolism and mortality

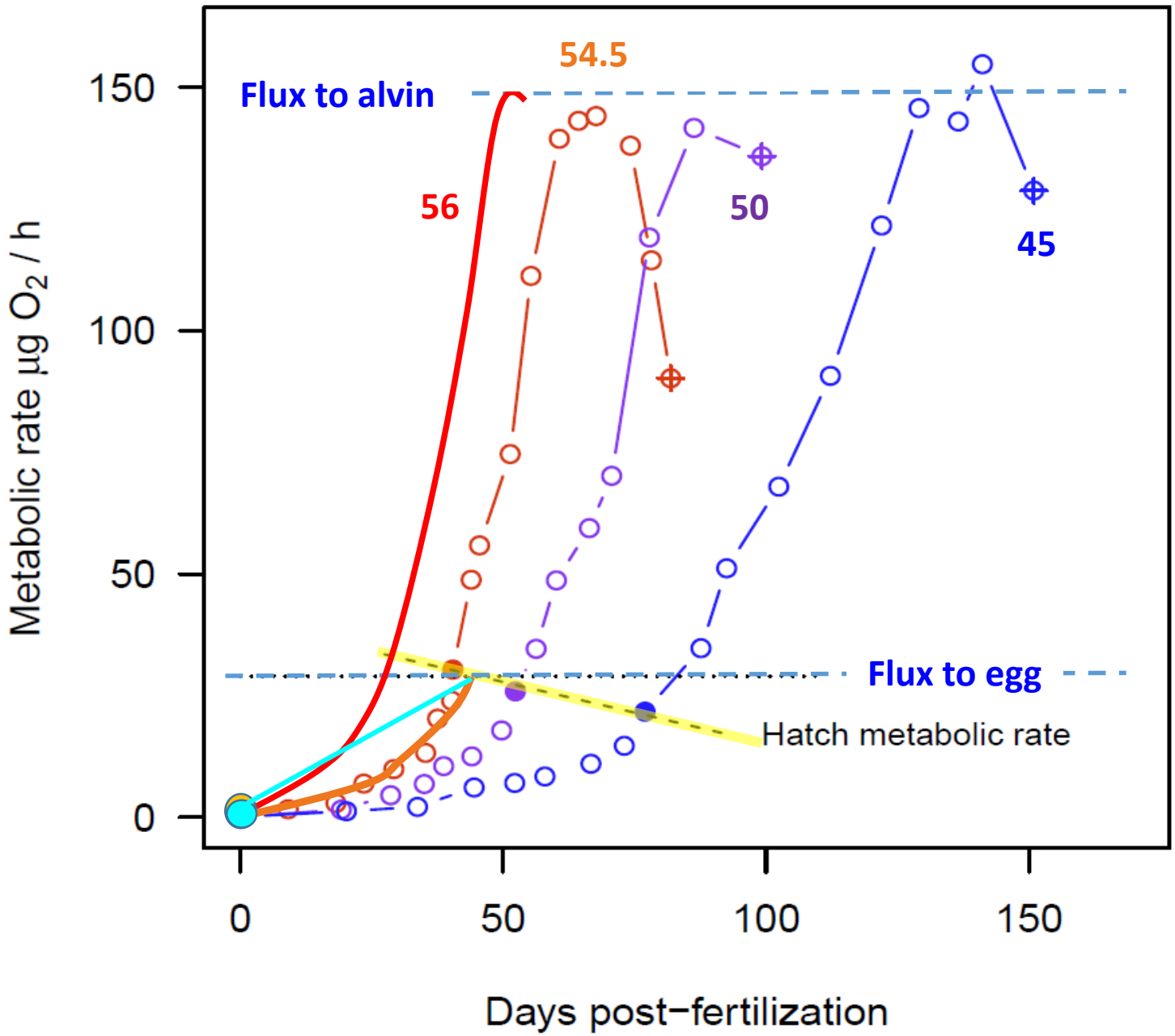
Background
Egg metabolism

Evidence for hatch O_2 sensitively



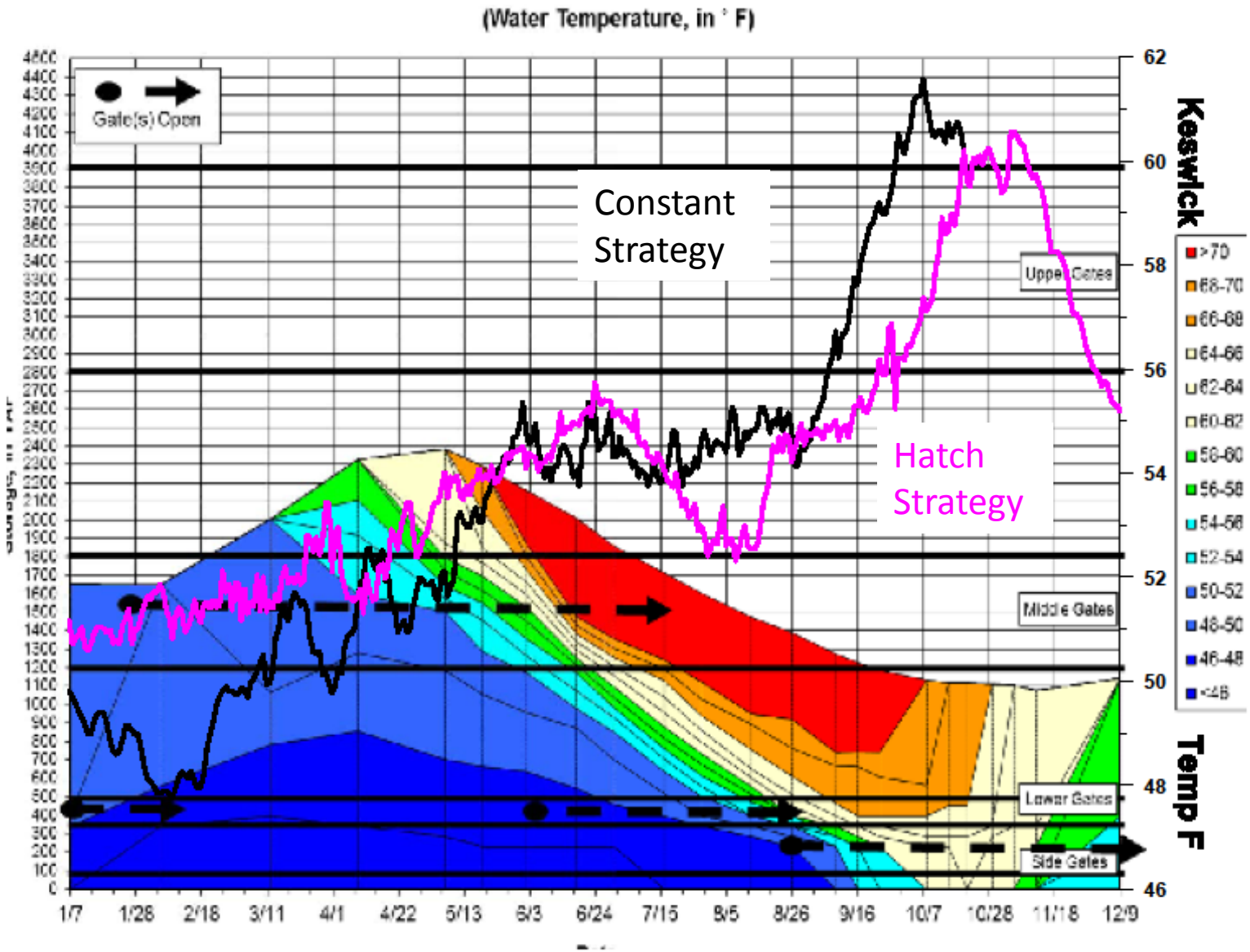
Steelhead at 12 °C
Redrawn from (Rombough 1986)

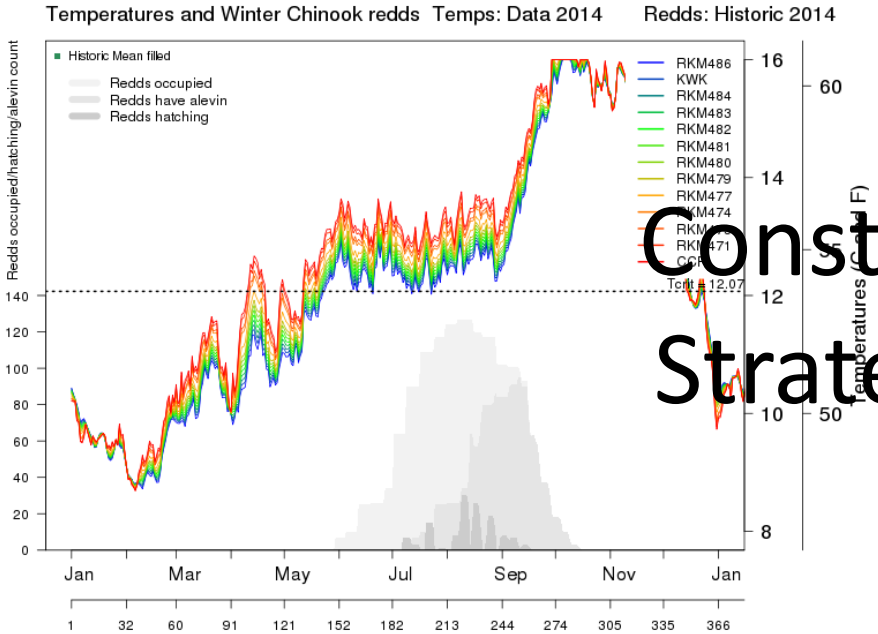
Fish view of constant vs. hatch strategies

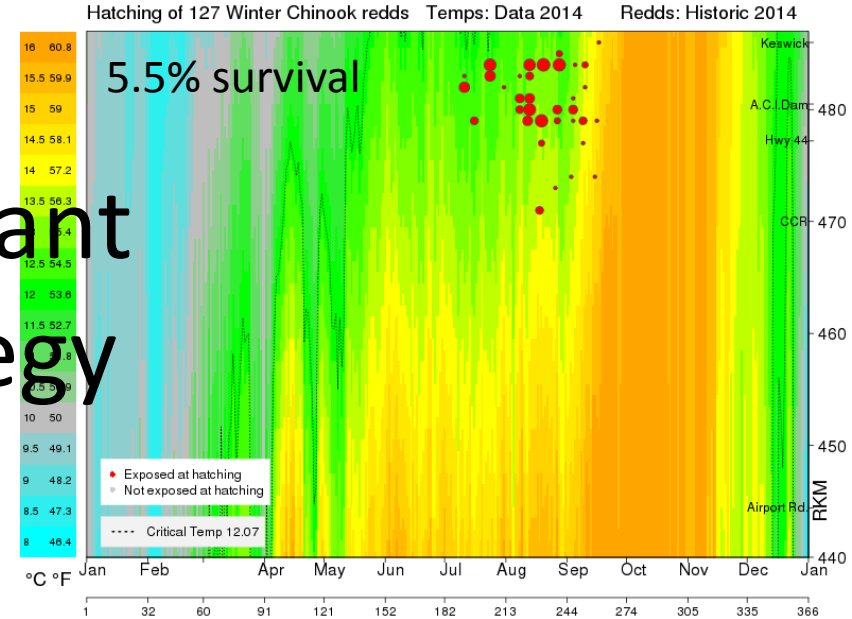

Flux to alvin
54.5
56
50
45
Flux to egg
Hatch metabolic rate
Metabolic rate µg O_2 / h
Days post−fertilization
0
50
100
150
0
50
100
150

Example 2014

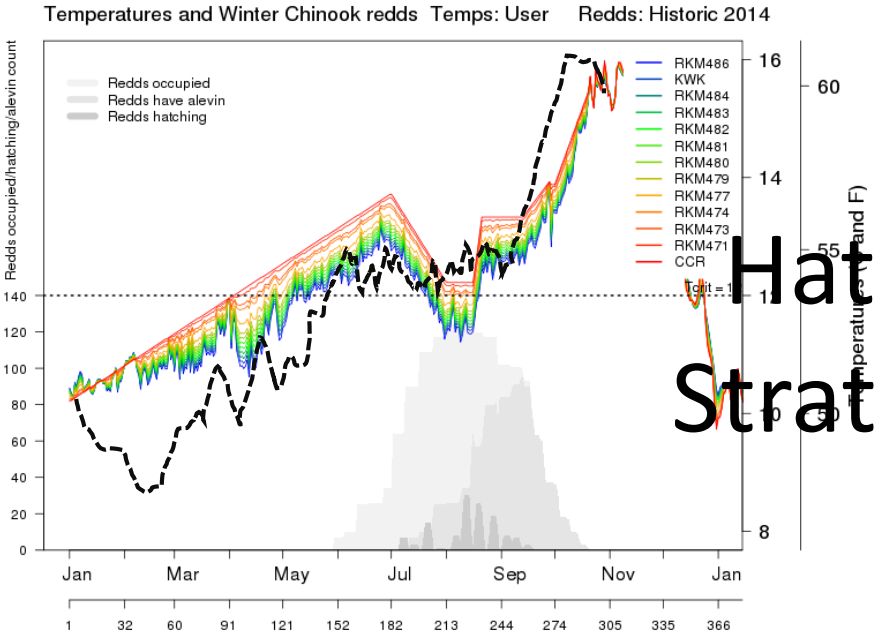
Constant vs. hatch strategy

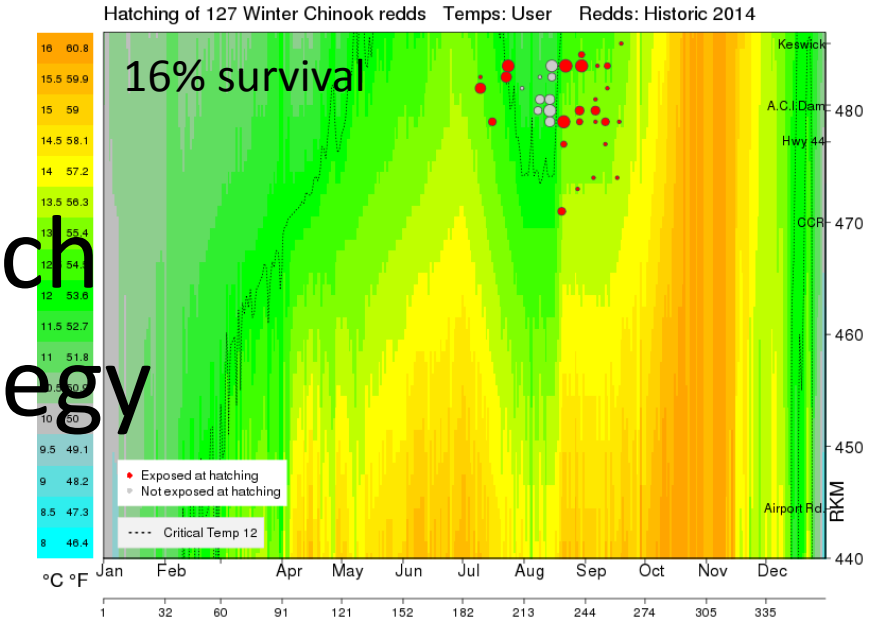

(Water Temperature, in ° F)
Gate(s) Open
Constant Strategy
Hatch Strategy
Upper Gates
Middle Gates
Lower Gates
Side Gates
Keswick
Temp F
>70
68-70
66-68
64-66
62-64
60-62
58-60
56-58
54-56
52-54
50-52
48-50
46-48
<46
62
60
58
56
54
52
50
48
46
1/7
1/28
2/18
3/11
4/1
4/22
5/13
6/3
6/24
7/15
8/5
8/26
9/16
10/7
10/28
11/18
12/9





Constant Strategy

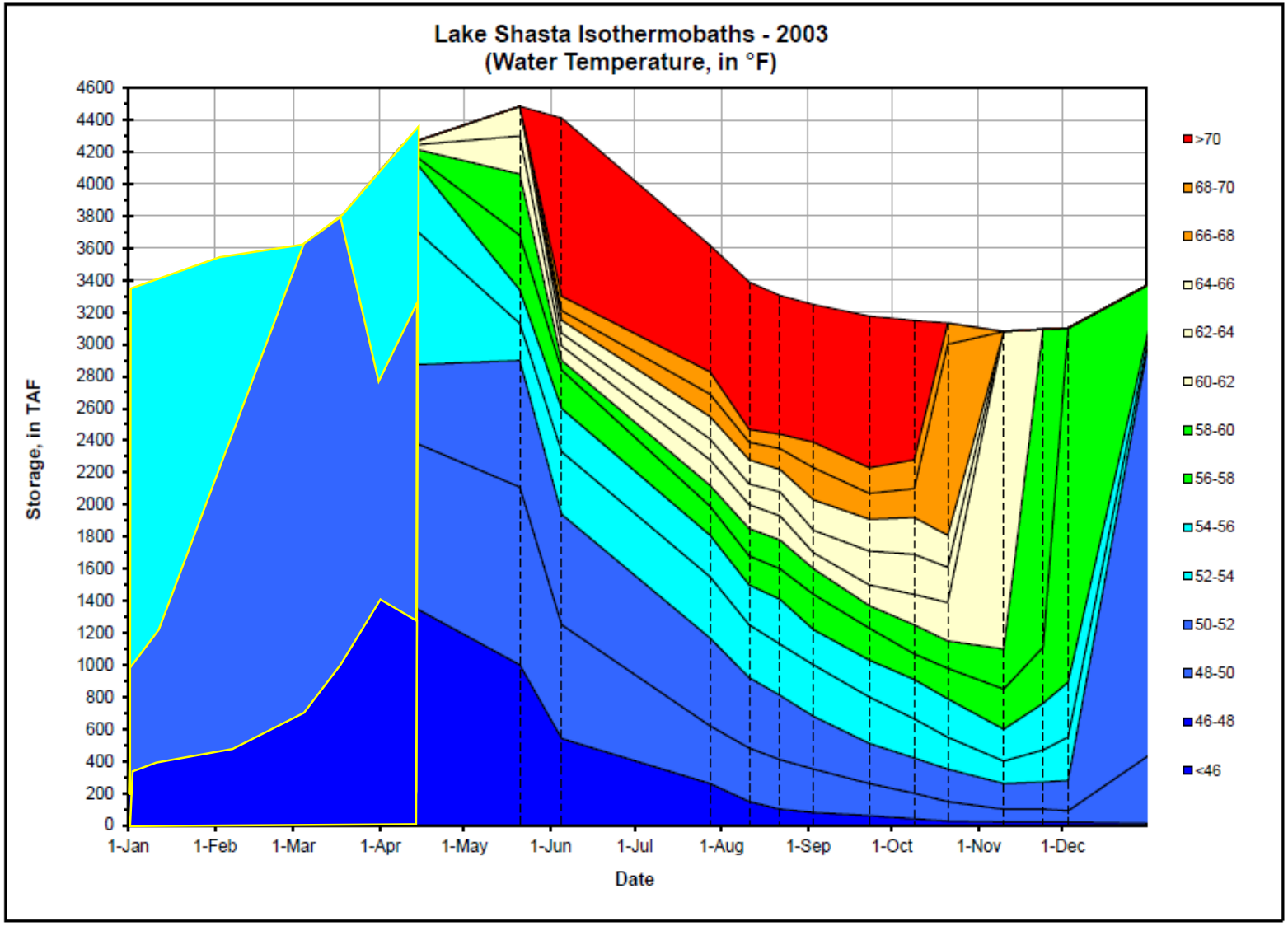




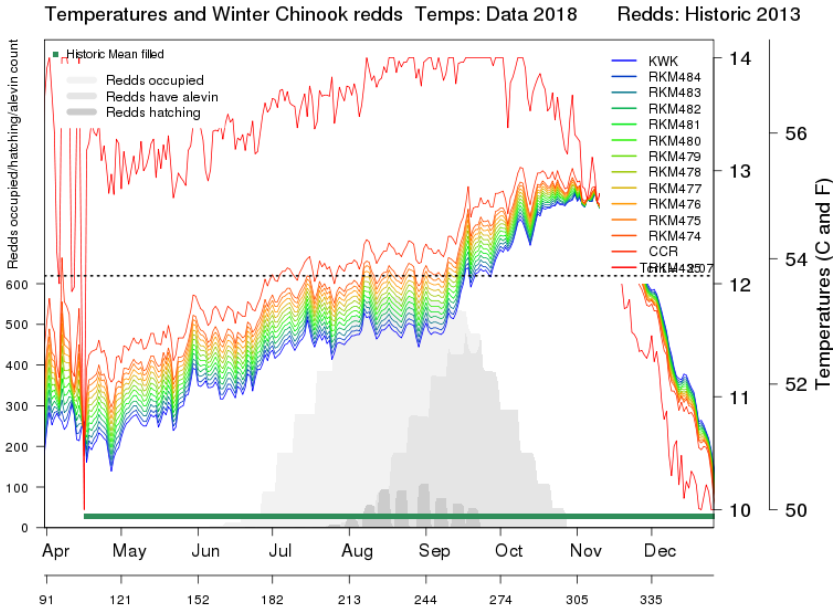
Hatch Strategy

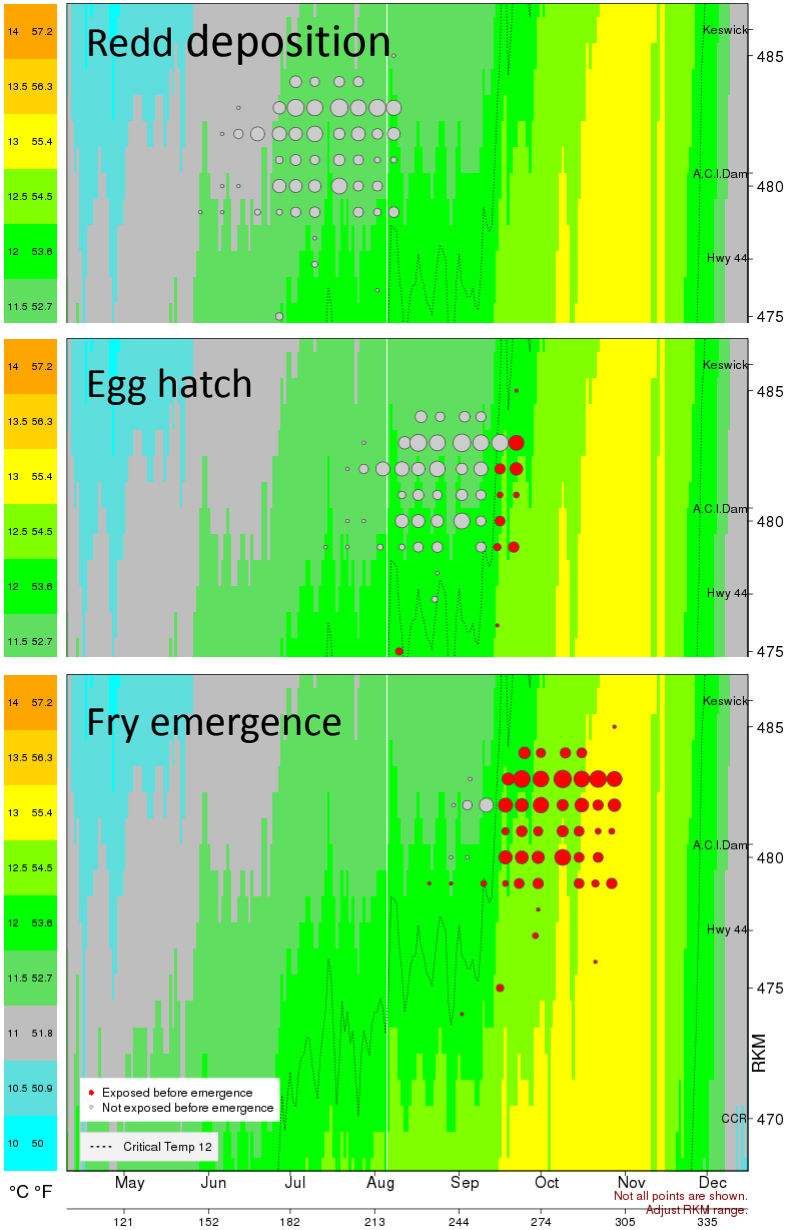
2018 Forecast

Constant Strategy


Lake Shasta Isothermobaths - 2003
(Water Temperature, in °F)
Storage, in TAF
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Date
>70
68-70
66-68
64-66
62-64
60-62
58-60
56-58
54-56
52-54
50-52
48-50
46-48
<46

2018 forecasts constant strategy



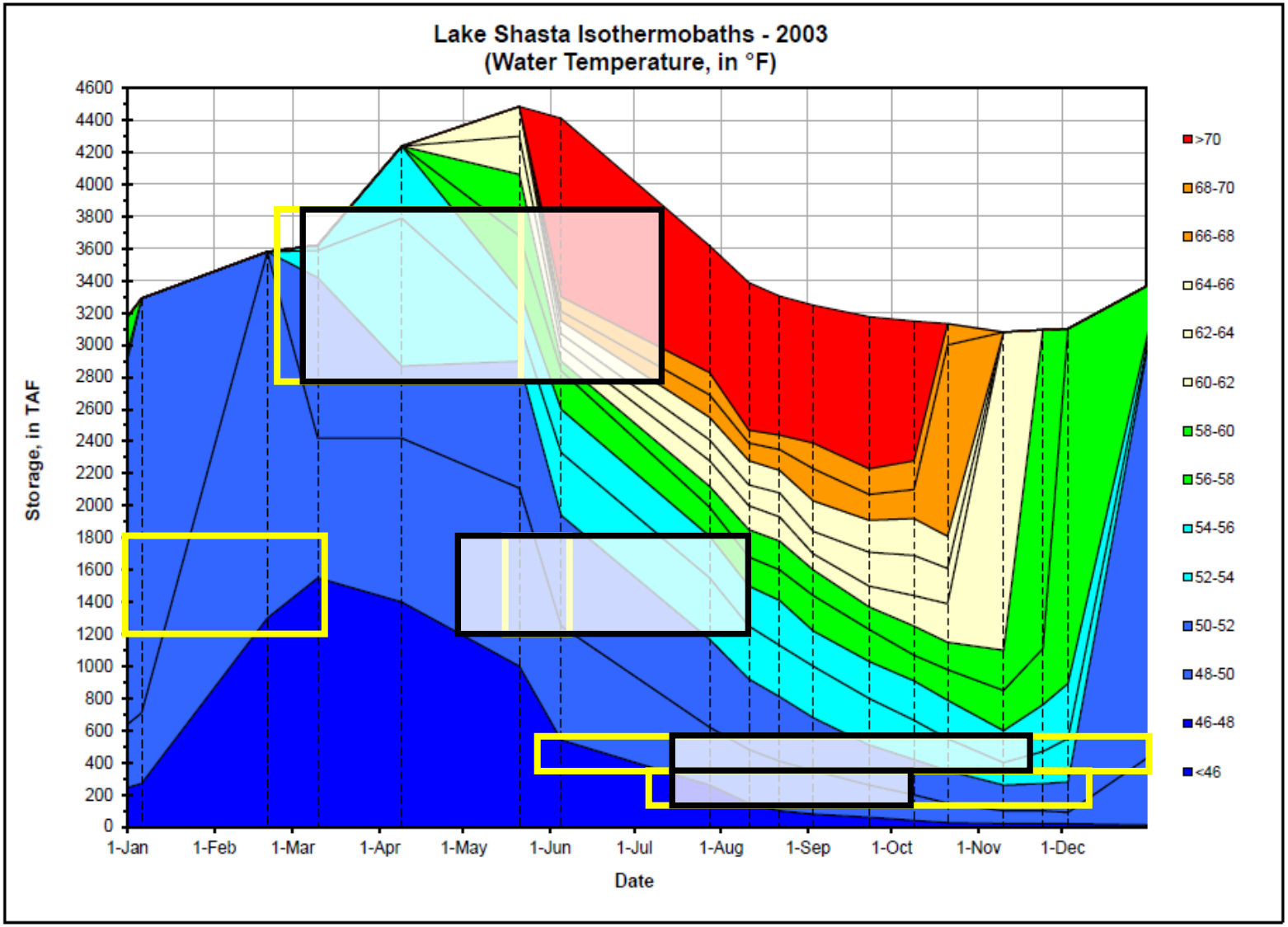


With 2012 redds (high density)
10 to 12% survival

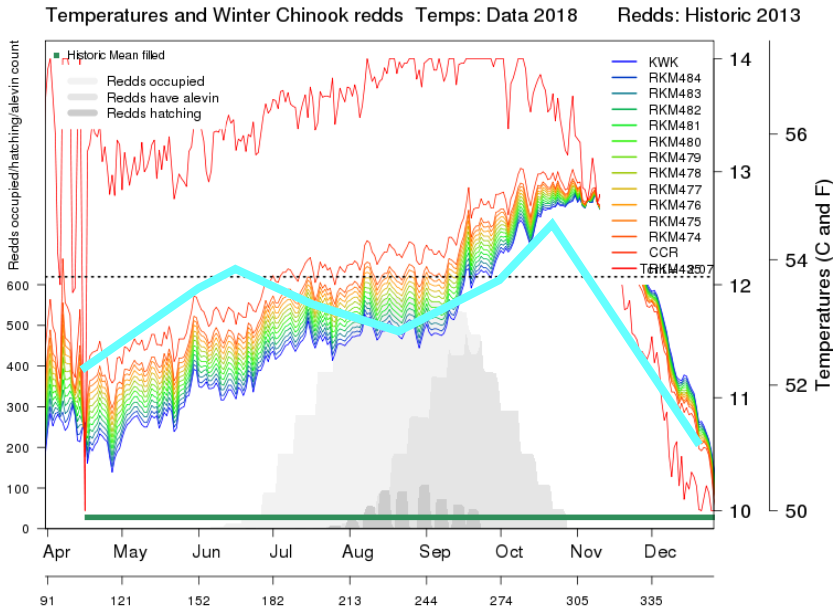
With 2016 redds (low density)
31 to 35% survival

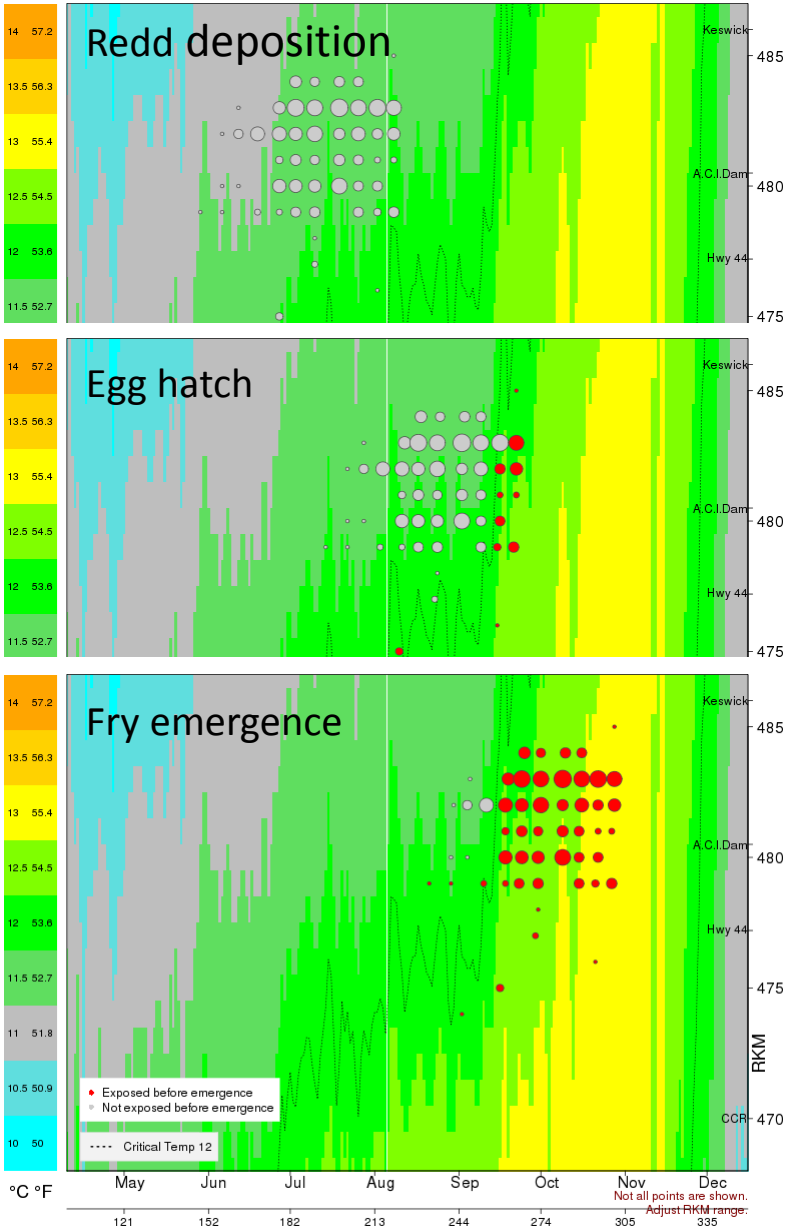
2018 Forecast

Hatch Strategy


Lake Shasta Isothermobaths - 2003
(Water Temperature, in °F)
Storage, in TAF
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1-Jan
1-Feb
1-Mar
1-Apr
1-May
1-Jun
1-Jul
1-Aug
1-Sep
1-Oct
1-Nov
1-Dec
Date
>70
68-70
66-68
64-66
62-64
60-62
58-60
56-58
54-56
52-54
50-52
48-50
46-48
<46

2018 hatch strategy





Potentially increase survival 10 to 100% depending on spawner density

Hatch Strategy steps

1. Raise temperature until first redd
2. Hold temperature to first hatch
3. Lower temperature to last hatch
4. Raise temperature