### Cultivating Ecological Solutions On Agricultural Lands

### by Mimicking Natural Process at the Landscape Scale

#### CALIFORNIA TROUT



FISH · WATER · PEOPLE

#### Jacob Katz – California Trout

C. Jeffres

## **Sacramento Valley**

1

## A Shifting Mosaic of Wetland Habitat Types



or lake Tidal freshwater emergent weband

Non-tidal freshwater emergent wetland

Willow thicket

Willow riparian scrub or shrub Valley foothill riparian

Wet meadow or seasonal wetland

Alkali seasonal wetland comp

Grassland Oak woodland or savanna

Dynamic Permanence Of the Land-Water Interface



### Sac Valley Defined by Puddles



# Development



# 13,000 miles of levees



#### The Land Divorced from the Water

# <u>Ubiquitous</u> Drainage



Central Valley wetlands lost

# Central Valley Chinook



### Of 4 runs, 3 are endangered, the other is dominated by hatcheries

# **Delta Smelt**

### Historic:

Fall run Chinook evolved rearing on floodplains

#### TODAY:

- 95% of floodplains lost
- drained and converted to rice.
- In California 550,000 acres of rice is farmed annually.
- Now, many of the rice fields are managed for migrating birds during winter months.



# We are never going back

American/ Natomas Basin

Yolo Basin

© aerialarchives.com

Sacramento Basin



Mimicking natural floodplain processes in post-harvest floodplain rice fields

### **Knaggs Ranch on Yolo Bypass**





## Post Rice Harvest - November, 2011















### Passive integrated transponder (PIT tags)





#### Fish measured every 2 weeks

#### After 6 weeks field drained

2.









# Nine 2-acre fields

### Replicated Ag Floodplains at Knaggs Ranch Hypotheses tested



# **Different Locations**

LLY PROJECT····CA



### Day 0 Day 38

# 2013

3/19 53 mm 1.5 g 4/27 90 mm 9.4 g

0.94 mm/d 0.18 g/d

# Similar Results



## Sacramento River

### 10 PIT tagged fish per pen

Floating Pens

### Floating Pens

# Tule Canal

### Managed Agricultural Floodplain

### Floating Pens



#### These fish were the same size 3 weeks prior to photo

Canal

Photo: J. Katz

Floodplain

3-11-2016

**River** 

#### **Fish Growth**



### The Food is on the Floodplain



Bug Density **149x** 

6x



### **Residence Time of Water** 2.15 days 23.5 sec 1.7 sec

#### Floodplain

50 -

100

250

Canal



200 -----

250



No. 1000

Total: 10,057/m^3

- 150

Total: 1,687/m^3

Sac. River

150

200

JUUTE

- 250

150

±5%

Total: 251,143m^3

200

250

No. 1000

# Inundated Floodplains are the

# **River's Solar Panels**

### It's Not Rocket Science



### **But it is Physics**



# Energy in correlates to Biomass out



**Pre-development** 

Today

Loss of Seasonally Inundated Floodplain

Floodplains are a Critical Energy Source for River and Delta Food Webs

# AQUATIC BIOPRODUCTIVITY

Aquatic Phytoplankton, Algae

Terrestrial Vegetation/ Detri

# The Process Doesn't Happen Instantaneously



# MAKING FISH



# TAKES TIME!





#### PERSPECTIVES

THE ROBERT H. MACARTHUR AWARD LECTURE

Ecology, 85(7), 2004, pp. 1771-1789 © 2004 by the Ecological Society of America

#### TOWARD A METABOLIC THEORY OF ECOLOGY

JAMES H. BROWN,<sup>12,4</sup> with JAMES F. GILLOOLY,<sup>1</sup> ANDREW P. ALLEN,<sup>1</sup> VAN M. SAVAGE,<sup>23</sup> AND GEOFFREY B. WEST<sup>23</sup>

<sup>1</sup>Department of Biology, University of New Mexico, Albuquerque, New Mexico 87131 USA <sup>1</sup>Sama Fe Institute, 1399 Hyde Park Road, Santa Fe, New Mexico 87501 USA <sup>1</sup>Theoretical Division, MS B285, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 USA



JAMES H. BROWN, MacArthur Award Recipient, 2002

Abstract. Metabolism provides a basis for using first principles of physics, chemistry, and biology to link the biology of individual organisms to the ecology of populations, communities, and ecosystems. Metabolic rate, the rate at which organisms take up, transform, and expend energy and materials, is the most fundamental biological rate. We have developed a quantitative theory for how metabolic rate varies with body size and temperature. Metabolic theory predicts how metabolic rate, by setting the rates of resource uptake from the environment and resource allocation to survival, growth, and reproduction, controls ecological processes at all levels of organization from individuals to the biosphere. Examples include: (1) life history attributes, including development rate, mortality rate, age at maturity, life span, and population growth rate; (2) population interactions, including carrying capacity, rates of competition and preduction, and patterns of species diversity; and (3) ecosystem processes, including rates of biomass production and respiration and patterns of trophic dynamiss.

Data compiled from the ecological literature strongly support the theoretical predictions. Eventually, metabolic theory may provide a conceptual foundation for much of ecology, just as genetic theory provides a foundation for much of evolutionary biology.

Key words: allometry; biogeochemical cycles; body size; development; ecological interactions; ecological theory; metabolism; population growth; production; stoichiometry; temperature; trophic dynamics.

# APPLYING THE **METABOLIC** THEORY OF **ECOLOGY** WATERSHEDS

Ecology, 85(7), 2004, pp. 1771-1789

# Spread it-Slow it-Sink it-Grow it





### Residence Time = Puddle Power



# Time for levee 2.0

Mano WHIRL-PAK WHIRL-PAK

#### Time to Stop Squandering The Valley's Natural Wealth

CALIFORNIA REPUBLIC

### Historic:

Fall run Chinook evolved rearing on floodplains

#### TODAY:

- 95% of floodplains lost
- drained and converted to rice.
- In California 550,000 acres of rice is farmed annually.
- Now, many of the rice fields are managed for migrating birds during winter months.



# the floodplain is still here

#### Access to Floodplain Energy – Biomass Plain to See



# **Puddle Power = Residence Time**



# Spread it - Slow it - Sink it - Grow it

# A Floodplain Partnership



#### Fins, Feathers, Farms and Flood Protection

# DRY SIDE

ATES DRETROFT

PTIMIZED - THESE ARE EXISTING ANI

#### ACTIVE FLOODPLAIN PROPOSALS IN THE LOWER SACRAMENTO RIVER VALLEY

REMAINING ACTIVE FLOODPLAIN -THESE ARE LOCATIONS WHERE JUVENILES HAVE THE OPPORTUNITY TO ENTER AND EXIT MIGH LIKE THEY DID DN HISTORIC FLOODPLAINS. THE CONCEPT IS TO REMARINE THE BYPAND REPLICATE THOSE HISTORIE THE BENEFIT OF THOSE HISTORIE THE BENEFIT OF TISH AND WILDLIFE.

Target: 250, 000 acres In 3 years

### Fish Food From Floodplain Farm Fields (FFFFF)



Target: 15,000 ac. In Yolo and Sutter Bypasses In next 3 years

Nigiri 2.0

WET SIDE

RANCH

CITY OF

RANCH

Legend

Elev (ft, 88)

10-11

21 - 22

# Real, Science-based Solutions

### **CA Water Solutions**



 $\star$ 

# **Global Impact**

# Process-Based Reconciliation Integrating a working knowledge of natural process, into management of natural resources



### Internet age

 We may live in the Internet Age, but California still relies on water infrastructure that dates from before the invention of the telephone. CA's water system was built more than 100 years ago, when very little was known about how rivers worked or how fish used them.

## **Pivot towards Process**

- California can produce an entirely different set of win-win outcomes for people ad environment if we integrate a working ecological understanding of landscape-scale processes into our land-use, farming practices and water management.
- The old ways separated species from the landscape.
- This new way integrates fish, wildlife and natural process into design and operation—creating sustainable water solutions with global impact.

### Stop Putting Band-aids on Cancer

 Move away from treating the symptoms and begin addressing the underlying landscapescale processes driving ecosystem collapse

## Reconciliation

- Endangered fish species are not an inevitable consequence of development
- Reconciling a 21<sup>st</sup> century scientific understanding of how rivers function with CA water management and operations benefits fish, birds and people.

### Resiliency in the face of Climate Change

- Managing for landscape and river function --->
- Creates and maintains diverse habitats --->
- Creates ecological resiliency --->
- Supports water security for farms and cities --->
- Promotes California's economic stability in an era of climatic change