AMERICAN FARMLAND TRUST · FARMLAND INFORMATION CENTER

FACT SHEET

WHY SAVE FARMLAND?

AMERICA'S AGRICULTURAL LAND IS AT RISK

Fertile soils take thousands of years to develop. Creating them takes a combination of climate, geology, biology and good luck. So far, no one has found a way to manufacture them. Thus, productive agricultural land is a finite and irreplaceable natural resource.

America's agricultural land provides the nation—and world—with an unparalleled abundance of food and fiber products. The dominant role of U.S. agriculture in the global economy has been likened to OPEC's in the field of energy. The food and farming system is important to the balance of trade and the employment of nearly 23 million people. Across the country, farmland supports the economic base of many rural and suburban communities.

Agricultural land also supplies products with little market value, but enormous cultural and ecological importance. Some are more immediate, such as social heritage, scenic views, open space and community character. Long-range environmental benefits include wildlife habitat, clean air and water, flood control, groundwater recharge and carbon sequestration.

Yet despite its importance to individual communities, the nation and the world, American farmland is at risk. It is imperiled by poorly planned development, especially in urban-influenced areas, and by the complex forces driving conversion. USDA's Economic Research Service reported that about 1,800 of the nation's 3,141 counties and county equivalents are "urban-influenced."[1] Many of these are important links in the American food chain. In 1997, farms in these urban-influenced counties produced 79 percent of dairy products, 90 percent of fruit, and 83 percent of vegetables.

According to USDA's National Resources Inventory (NRI), from 1992 to 1997 more than 11 million acres of rural land were converted to developed use—and more than half of that conversion was agricultural land. In that period, an average of more than 1 million agricultural acres were developed each year. And the rate is increasing—up 51 percent from the rate reported in the previous decade.

Agricultural land is desirable for building because it tends to be flat, well drained and generally is more affordable to developers than to farmers and ranchers. Far more farmland is being converted than is necessary to provide housing for a growing population. Over the past 20 years, the acreage per person for new housing almost doubled.[2] Most of this land is outside of existing urban areas. Since 1994, lots of 10 to 22 acres accounted for 55 percent of the growth in housing area.[3] The NRI shows that the best agricultural soils are being developed fastest.

THE FOOD AND FARMING SYSTEM

The U.S. food and farming system contributes nearly $1 trillion to the national economy—or more than 13 percent of the gross domestic product—and employs 17 percent of the labor force.[4] With a rapidly increasing world population and expanding global markets, saving American farmland is a prudent investment in world food supply and economic opportunity.

Asian and Latin American countries are the most significant consumers of U.S. agricultural exports. Latin America, including Mexico, purchases an average of about $10.6 billion of U.S. agricultural exports each year. Asian countries purchase an average of $23.6 billion/year, with Japan alone accounting for about $10 billion/year.[5] Even as worldwide demand for a more diverse diet increases, many countries are paving their arable land to support rapidly expanding economies. Important customers today, they are expected to purchase more agricultural products in the future.

While domestic food shortages are unlikely in the short term, the U.S. Census predicts the population will grow by 42 percent in the next 50 years. Many developing nations already are concerned about food security.

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The Farmland Information Center is a public/private partnership between American Farmland Trust and the USDA Natural Resources Conservation Service that provides technical information about farmland protection.

WHY SAVE FARMLAND?

The Farmland Information Center offers publications, an on-line library and technical assistance. For additional information on farmland protection, Call (800) 370-4879. Or visit us on the web at www.farmlandinfo.org

Of the 78 million people currently added to the world each year, 95 percent live in less developed regions.[6] The productivity and diversity of American agriculture can ensure food supplies and continuing preeminence in world markets. But this depends upon an investment strategy that preserves valuable assets, including agricultural land, to supply rapidly changing global demand.

FISCAL AND ECONOMIC STABILITY

Saving farmland is an investment in community infrastructure and economic development. It supports local government budgets and the ability to create wealth locally. In addition, distinctive agricultural landscapes are often magnets for tourism.

People vacation in the state of Vermont or Steamboat Springs, Colo., because they enjoy the scenery created by rural meadows and grazing livestock. In Lancaster, Pa., agriculture is still the leading industry, but with Amish and Mennonites working in the fields, tourism is not far behind. Napa Valley, Calif., is another place known as a destination for "agro tourism." Tourists have become such a large part of most Napa Valley wineries that many vintners have hired hospitality staff. Both the valley and the wines have gained name recognition, and the economy is thriving.

Agriculture contributes to local economies directly through sales, job creation, support services and businesses, and also by supplying lucrative secondary markets such as food processing. Planning for agriculture and protecting farmland provide flexibility for growth and development, offering a hedge against fragmented suburban development while supporting a diversified economic base.

Development imposes direct costs to communities, as well as indirect costs associated with the loss of rural lands and open space.[7] Privately owned and managed agricultural land generates more in local tax revenues than it costs in services. Carefully examining local budgets in cost of community services (COCS) studies shows that nationwide farm, forest and open lands more than pay for the municipal services they require, while taxes on residential uses consistently fail to cover costs.[8] (See COCS fact sheet.) Related studies measuring the effect of all types of development on municipal tax bills find that tax bills generally go up as communities become more developed. Even those communities with the most taxable commercial and industrial properties have higher-than-average taxes.[9]

Local governments are discovering that they cannot afford to pay the price of unplanned development. Converting productive agricultural land to developed uses creates negative economic and environmental impacts. For example, from the mid-1980s to the mid-1990s, the population of Atlanta, Ga., grew at about the same rate as that of Portland, Ore. Due to its strong growth management law, the size of Portland increased by only 2 percent while Atlanta doubled in size. To accommodate its sprawling growth, Atlanta raised property taxes 22 percent while Portland lowered property taxes by 29 percent. Vehicle miles traveled (and related impacts) increased 17 percent in Atlanta but only 2 percent in Portland.[10]

ENVIRONMENTAL QUALITY

Well-managed agricultural land supplies important non-market goods and services. Farm and ranch lands provide food and cover for wildlife, help control flooding, protect wetlands and watersheds, and maintain air quality. They can absorb and filter wastewater and provide groundwater recharge. New energy crops even have the potential to replace fossil fuels.

The federal government owns 402 million acres of forests, parks and wildlife refuges that provide substantial habitat for wildlife. Most of this land is located in 11 western states. States, municipalities and other non-federal units of government also own land. Yet public agencies alone cannot sustain wildlife populations. Well-managed, privately owned agricultural land is a critical resource for wildlife habitat.

With nearly 1 billion acres of land in farms, agriculture is America's dominant land use. So it is not surprising that farming has a significant ecological impact. Ever since the publication of Rachel Carson's *Silent Spring*, environmentalists have called attention to the negative impacts of industrial agricultural practices. However, converting farmland to development has detrimental long-term impacts on environmental quality.

Water pollution from urban development is well documented.[9] Development increases pollution of rivers and streams, as well as the risk of flooding. Paved roads and roofs collect and pass storm water directly into drains instead of filtering it naturally through the soil.[11] Septic systems for low-density subdivisions can add untreated wastes to surface water and groundwater—potentially yielding higher nutrient loads than livestock operations.[12] Development often produces more sediment and heavy metal contamination than farming does and increases pollutants—such as road salt, oil leaks from automobiles and runoff from lawn chemicals—that lead to groundwater contamination.[13] It also decreases recharge of aquifers, lowers drinking-water quality and reduces biodiversity in streams.

Urban development is a significant cause of wetland loss.[14] Between 1992 and 1997, NRI showed that development was responsible for 49 percent of the total loss. Increased use of automobiles leads to traffic congestion and air pollution. Development fragments and often destroys wildlife habitat, and fragmentation is considered a principal threat to biodiversity.[15]

Keeping land available for agriculture while improving farm management practices offers the greatest potential to produce or regain environmental and social benefits while minimizing negative impacts. From wetland management to on-farm composting for municipalities, farmers are finding ways to improve environmental quality.

HERITAGE AND COMMUNITY CHARACTER

To many people, the most compelling reasons for saving farmland are local and personal, and much of the political support for farmland protection is driven by grassroots community efforts. Sometimes the most important qualities are the hardest to quantify—such as local heritage and sense of place. Farm and ranch land maintain scenic, cultural and historic landscapes. Their managed open spaces provide beautiful views and opportunities for hunting and fishing, horseback riding, skiing, dirt-biking and other recreational activities. Farms and ranches create identifiable and unique community character and add to the quality of life. Perhaps it is for these reasons that the contingent valuation studies typically find that people are willing to pay to protect agricultural land from development.

Finally, farming is an integral part of our heritage and our identity as a people. American democracy is rooted in an agricultural past and founded on the principle that all people can own property and earn a living from the land. The ongoing relationship with the agricultural landscape connects Americans to history and to the natural world. Our land is our legacy, both as we look back to the past and as we consider what we have of value to pass on to future generations.

Public awareness of the multiple benefits of working lands has led to greater community appreciation of the importance of keeping land open for fiscal, economic and environmental reasons. As a result, people increasingly are challenging the perspective that new development is necessarily the most desirable use of agricultural land—especially in rural communities and communities undergoing transition from rural to suburban.

ENDNOTES

[1] **Agriculture and the Rural Economy: Urbanization Affects a Large Share of Farmland.** *Rural Conditions and Trends*. Vol. 10, Number 2, July 2000 http:/www.ers.usda.gov/epubs/pdf/rcat/rcat102/rcat102k.pdf.

[2] U.S. Department of Housing and Urban Development, State of the Cities 2000, Fourth Annual, June 2000; http://www.hud.gov/library/bookshelf18/pressrel/socrpt.pdf; Internet.

[3] **Development at the Urban Fringe and Beyond: Impacts on Agriculture and Rural Land.** Ralph E. Heimlich and William D. Anderson. Economic Research Service, USDA. Agricultural Economic Report No. 803. p.14.

[4] **The Food and Fiber System: Contributing to U.S. and World Economies.** Kathryn Lipton, William Edmondson and Alden Manchester. ERS, USDA. Agriculture Information Bulletin No. 742. July 1998.

[5] U.S. Census Bureau. Statistical Abstract of the United States 2001. p.535.

[6] **The World at Six Billion**; United Nations Population Division; p.3.

[7] Heimlich, op cit.

[8] **Making the Case for Land Conservation: Fifteen Years of Cost of Community Services Studies.** Freedgood, Julia. American Farmland Trust. Northampton, Mass., 2002.

[9] **Community Choices: Thinking Through Land Conservation, Development, and Property Taxes in Massachusetts.** Deb Brighton. Boston, Mass.: The Trust for Public Land, 1999.

[10] **New Research on Population, Suburban Sprawl and Smart Growth.** sierraclub.org/sprawl.

[11] **The Costs of Sprawl: Environmental and Economic Costs of Alternative Development Patterns at the Urban Fringe.** Real Estate Research Corporation. U.S. Government Printing Office. Washington D.C. 1974. **Development on the Urban Fringe and Beyond,** op cit. **Impact Assessment of New Jersey Interim State Development and Redevelopment Plan, Report II.** Robert W. Burchell. N.J. Office of State Planning. Trenton, N.J. 1992.

[12] **Septic Tanks, Lot Size and Pollution of Water Table Aquifers.** R.J. Perkins. *Journal of Environmental Health* 46 (6). 1984.

[13] **Nitrate-Nitrogen Losses to Ground Water from Rural and Suburban Land Uses.** A. J. Gold, et al. *Journal of Soil and Water Conservation.* March April 1990. **Results of the Nationwide Urban Runoff Program, Volume 1 - Final Report.** U.S. Environmental Protection Agency. Washington, D.C. 1983.

[14] **Development on the Urban Fringe and Beyond,** op cit. **The Costs of Sprawl.** Maine State Planning Office. 1997.

[15] **Development on the Urban Fringe and Beyond,** op cit. **Preserving Communities and Corridors.** G. Mackintosh, ed. Defenders of Wildlife. Washington, D.C. 1989. **Saving Nature's Legacy.** R.F. Noss and A.Y. Cooperrider. Island Press. Washington, D.C. 1994.

Species List

Table A-1
Mammals Known to Utilize Rice Culture Habitats During Their Annual Cycle

Common Name	Scientific Name
Virginia opossum	*Didelphis virginiana*
Ornate shrew	*Sorex ornatus*
California myotis	*Myotis californicus*
Red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Pallid bat	*Anthrozous pallidus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Desert cottontail	*Sylvilagus audubonii*
Black-tailed jackrabbit	*Lepus californicus*
California ground squirrel	*Spermophilus beecheyi*
Botta's pocket gopher	*Thomomys bottae*
Western harvest mouse	*Reithrodontomys megalotis*
Deer mouse	*Peromyscus maniculatus*
California vole	*Microtus californicus*
Muskrat	*Ondatra zibethicus*
Black rat	*Rattus rattus*
Norway rat	*Rattus norvegicus*
House mouse	*Mus musculus*
Coyote	*Canis latrans*
Red fox	*Vulpes fulva*
Gray fox	*Urocyon cinereoargenteus*
Ringtail	*Bassariscus astutus*
Mink	*Mustela vison*
Western spotted skunk	*Spilogale putorius*
Striped skunk	*Mephitis mephitis*
River otter	*Lutra canadensis*
Black-tailed deer	*Odocoileus hemionus*
Beaver	*Castor canadensis*

Table A-2

Hooded Merganser	*Lophodytes cucullatus*
Common Merganser	*Mergus merganser*
Ruddy Duck	*Oxyura jamaicensis*
Turkey Vulture	*Cathartes aura*
White-tailed Kite	*Elanus leucurus*
Bald Eagle	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*
Swainson's Hawk	*Buteo swainsoni*
Red-tailed hawk	*Buteo jamaicensis*
Ferruginous hawk	*Buteo regalis*
Rough-legged Hawk	*Buteo lagopus*
Golden Eagle	*Aquila chrysaetos*
American kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Prairie Falcon	*Falco mexicanus*
Ring-necked Pheasant	*Phasianus colchicus*
Sora	*Porzana carolina*
Common moorhen	*Gallinula chloropus*
American Coot	*Fulica americana*
Greater Sandhill Crane	*Grus canadensis tabida*
Black-bellied Plover	*Pluvialis squatarola*
Killdeer	*Charadrius vociferus*
Mountain Plover	*Charadrius montanus*
Black-necked Stilt	*Himantopus mexicanus*
American Avocet	*Recurvirostra americana*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Solitary Sandpiper	*Tringa solitaria*
Willet	*Catoptrophorus semipalmatus*
Spotted Sandpiper	*Actitis macularia*
Whimbrel	*Numenius phaeopus*
Long-billed Curlew	*Numenius americanus*
Marbled Godwit	*Limosa fedoa*
Western Sandpiper	*Calidris mauri*
Least Sandpiper	*Calidris minutilla*
Baird's Sandpiper	*Calidris bairdii*
Dunlin	*Calidris alpina*

Birds Known to Utilize Flooded Rice Fields, or Set-Aside During Their Annual Cycle

Common Name	Scientific Name
Pied-billed Grebe	*Podilymbus podiceps*
Eared Grebe	*Podiceps nigricollis*
Clark's Grebe	*Aechmophorus clarkii*
American White Pelican	*Pelecanus erythrorhynchos*
Double-crested Cormorant	*Phalacrocorax auritus*
American Bittern	*Botaurus lentiginosus*
Great Blue heron	*Ardea herodias*
Great Egret	*Ardea alba*
Snowy Egret	*Egretta thula*
Cattle Egret	*Bubulcus ibis*
Green Heron	*Butorides virescens*
Black-crowned Night Heron	*Nycticorax nycticorax*
White-faced Ibis	*Plegadis chihi*
Tundra Swan	*Cygnus columbianus*
Greater White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Ross' Goose	*Chen rossii*
Brant	*Branta bernicla*
Canada Goose	*Branta canadensis*
Aleutian Canada Goose	*Branta canadensis leucopareia*
Wood Duck	*Aix sponsa*
Green-winged Teal	*Anas crecca*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Blue-winged Teal	*Anas discors*
Cinnamon Teal	*Anas cyanoptera*
Northern Shoveler	*Anas clypeata*
Gadwall	*Anas strepera*
Eurasian Wigeon	*Anas penelope*
American Wigeon	*Anas americana*
Canvasback	*Aythya valisineria*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Greater Scaup	*Aythya marila*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*bucephala clangula*
Bufflehead	*Bucephala albeola*

Loggerhead shrike	*Lanius ludovicianus*
European Starling	*Sturnus vulgaris*
Yellow-rumped Warbler	*Dendroica coronata*
Lark Sparrow	*Chondestes grammacus*
Savannah Sparrow	*Passerculus sandwichensis*
Fox Sparrow	*Passerella iliaca*
Song Sparrow	*Melospiza melodia*
Lincoln's Sparrow	*Melospiza lincolnii*
Golden-crowed Sparrow	*Zonotrichia atricapilla*
White-crowned Sparrow	*Zonotrichia leucophrys*
Harris' Sparrow	*Zonotrichia querula*
Dark-eyed Junco	*Junco hyemalis*
Red-winged Blackbird	*Agelaius phoeniceus*
Tricolored Blackbird	*Agelaius tricolor*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Brown-headed Cowbird	*Molothrus ater*
House Finch	*Carpodacus mexicanus*
Lesser Goldfinch	*Carduelis psaltria*
American Goldfinch	*Carduelis tristis*
House Sparrow	*Passer domesticus*

Table A-3
Amphibians and Reptiles Known to Utilize Rice Culture Habitats During Their Life Cycle

Common Name	Scientific Name
California slender salamander	*Batrachoseps attenuatus*
Western spadefoot toad	*Scaphipous hammondii*
Western toad	*Bufo boreas*
Pacific treefrog	*Pseudacris regilla*
Bullfrog	*Rana catesbeiana*
Leopard frog	*Rana pipiens*
Western pond turtle	*Clemmys marmorata*
Western fence lizard	*Sceloporus occidentalis*
Coast horned lizard	*Phrynosoma coronatum*
Gilbert's skink	*Eumeces gilberti*
Western skink	*Eumeces skiltonianus*

Western whiptail	*Cnemidophorus tigris*
Southern alligator lizard	*Gerrhonotus multicarinatus*
Sharp-tailed snake	*Contia tenuis*
Coachwhip	*Masticophis flagellum*
Racer	*Coluber constrictor*
Gopher snake	*Pituophis melanoleucus*
Common king snake	*Lampropeltis getulus*
Long-nosed snake	*Rhinocheilus lecontei*
Common garter snake	*Thamnophis sirtalis*
Western garter snake	*Thamnophis elegans*
Giant garter snake	*Thamnophis gigas*
Night snake	*Hypsiglena torquata*
Western rattlesnake	*Crotalus viridis*

CENTRAL VALLEY CHINOOK GENETIC CHARACTERIZATION IN THE DELTA

EWA Workshop July 2003, Sheila Greene

- Individual Identification – Winter Run
- Calculating Loss at the Delta Exports
- Delta Monitoring Program
- Program Management
- Individual Identification – Spring Run

INDIVIDUAL IDENTIFICATION
- WINTER RUN

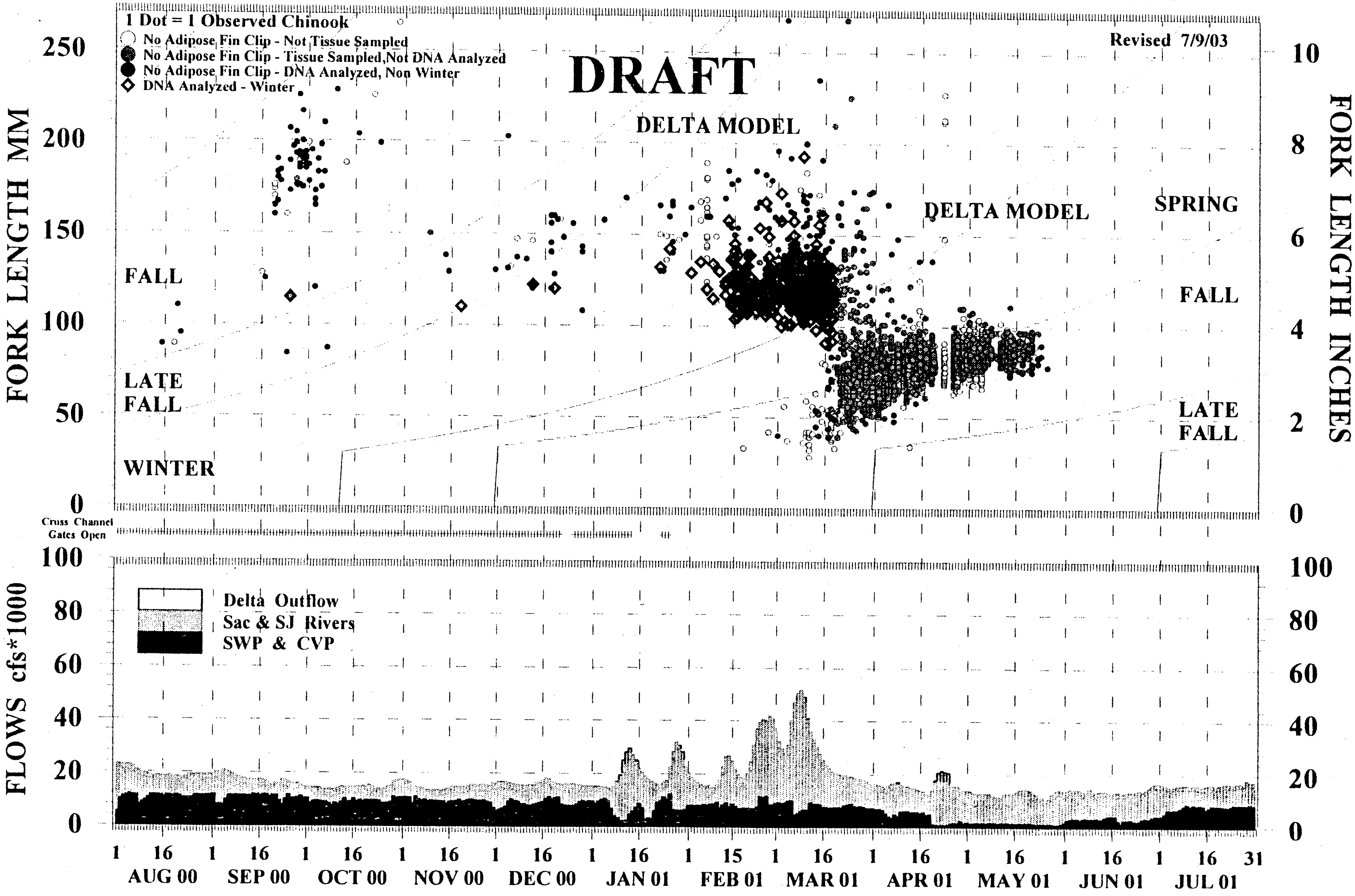
- Population Structure Paper Published, CJFAS, 2000 (copies in the back)
- Individual Identification Paper Published, J Heredity, 2000 (copies in the back)
- Accuracy 99% using 7 loci (modeling baselines)
- Working on "Mis-Identification Rate" for an Individual

slg

CALCULATING LOSS AT THE DELTA EXPORTS

- Just use 4 Pumps Mitigation Agreement Calculation on individual genetic winter run
    - but haven't successfully tissue sampled all salvaged Chinook
- Assign non-analyzed salvage the genetic identification of nearest neighbors
- New length criterion using genetic characterization

OBSERVED CHINOOK SALVAGE AT THE SWP DELTA FISH FACILITIES 8/1/00 THROUGH 7/31/01



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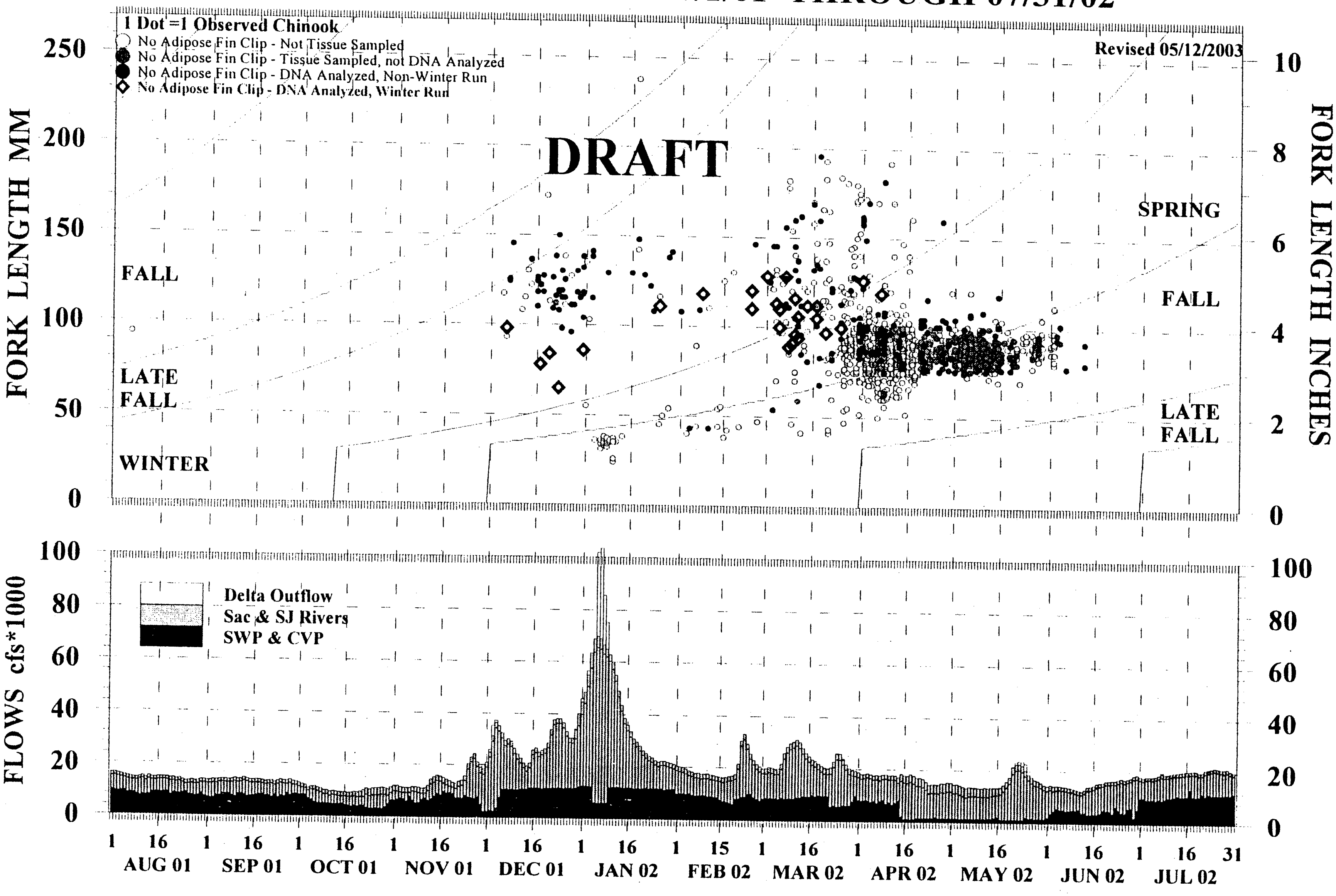
OBSERVED CHINOOK SALVAGE AT THE SWP
DELTA FISH FACILITIES 8/1/01 THROUGH 07/31/02



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WINTER RUN CHINOOK LOSS CALCULATED BASED ON LENGTH CRITERION AND GENETIC CHARACTERIZATION IDENTIFICATION

DRAFT	1999/2000		2000/2001		2001/2002	
	SWP	CVP	SWP	CVP	SWP	CVP
Length Criterion Identification Loss	5,324	506	18,840	1,219	2,750	545
Genetic Characterization Identification Loss	1,391	349	14,120	807	607	183
Fraction Genetic Characterization Loss of Length Criterion Loss	0.26	0.69	0.75	0.66	0.22	0.34

slg

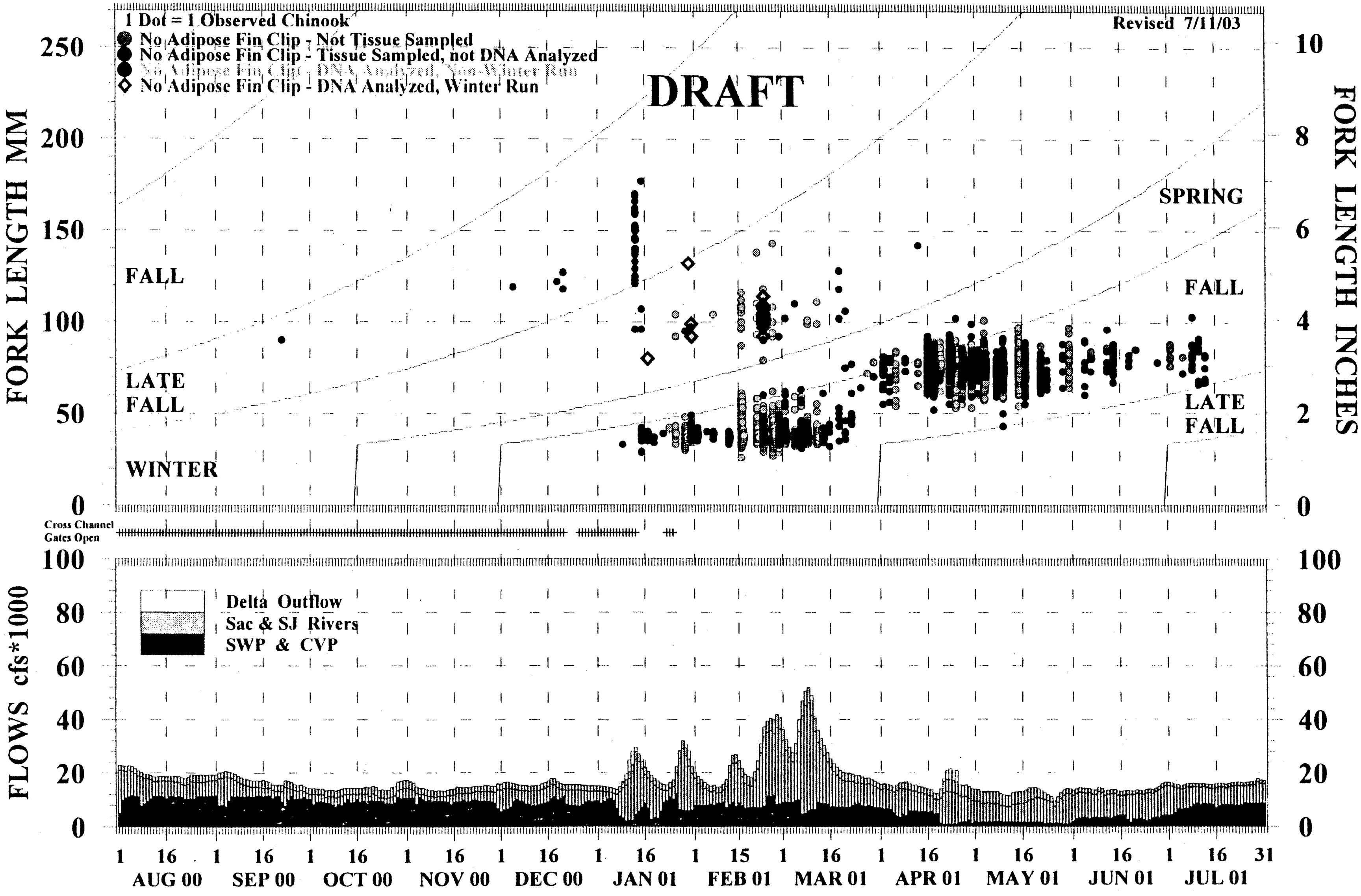
CALCULATING LOSS AT THE DELTA EXPORTS

- Just use 4 Pumps Mitigation Agreement Calculation on genetic winter run
    - but haven't successfully tissue sampled all salvaged Chinook
- Assign non-analyzed salvage the genetic identification of nearest neighbors
- New length criterion using genetic characterization

DELTA MONITORING PROGRAM

- Sampling not systematic or consistent
  - just due to lack of funding
- Presence / Absence, when sampling

CHINOOK RECOVERED IN THE SACRAMENTO TRAWL AND DNA ANALYZED 8/1/00 THROUGH 7/31/01



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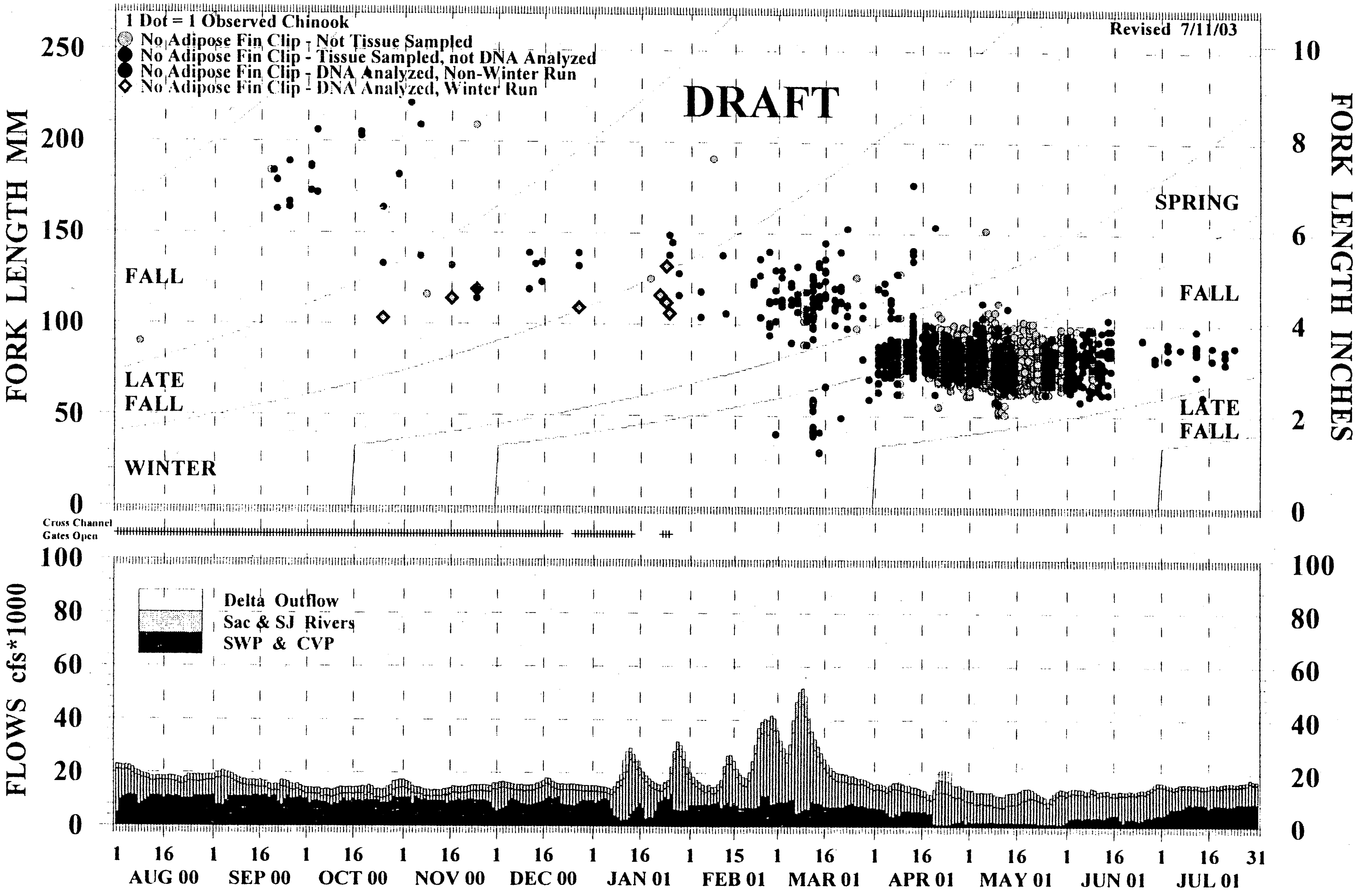
CHINOOK RECOVERED IN THE CHIPPS ISLAND TRAWL AND DNA ANALYZED 8/1/00 THROUGH 7/31/01



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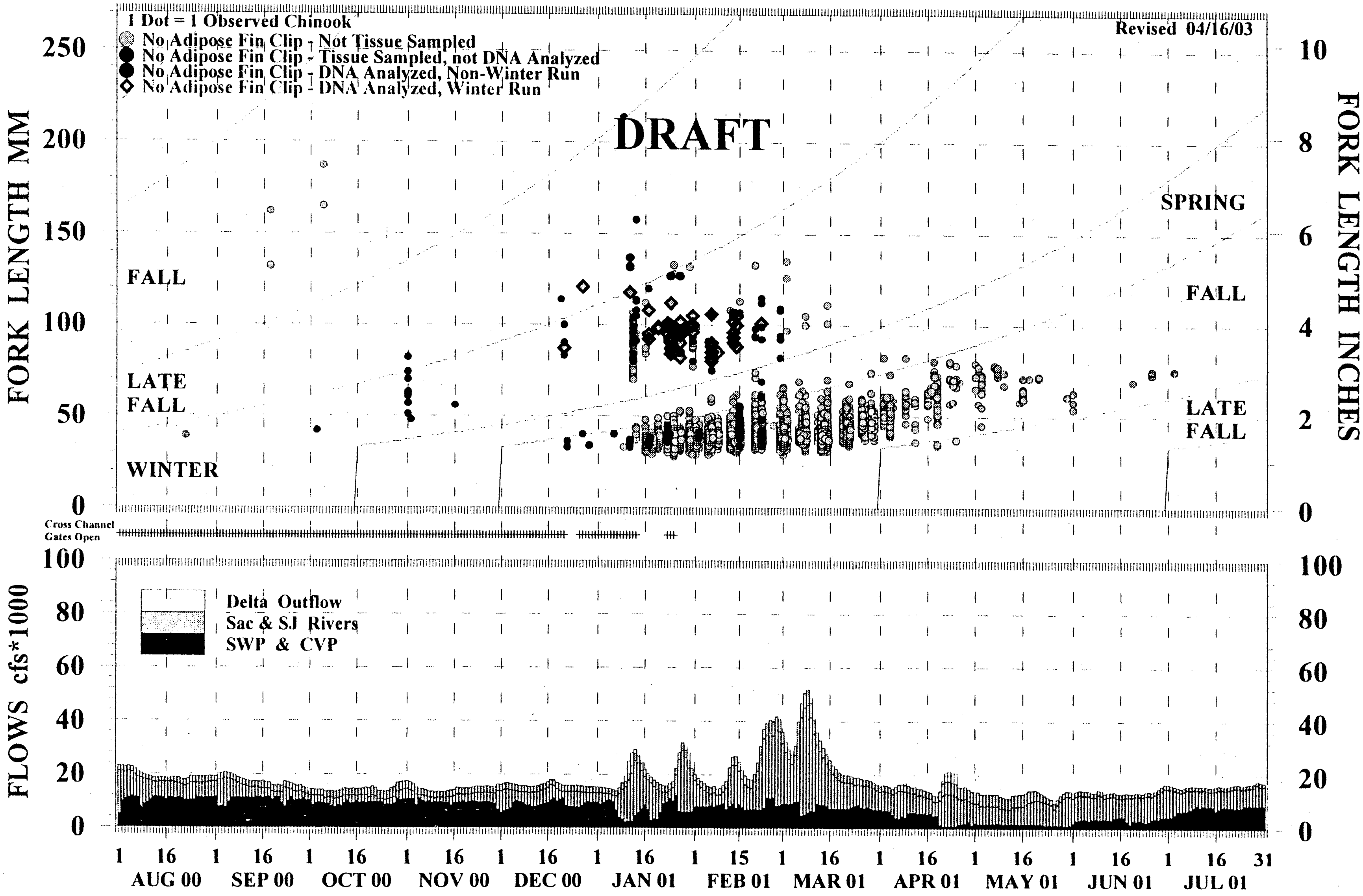
CHINOOK RECOVERED IN THE SAC/SAN BEACH SEINES AND DNA ANALYZED 8/1/00 THROUGH 7/31/01



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PROGRAM MANAGEMENT

- Genetic Contract
- Collection
- Collection Coordination and Transportation
- DFG Archive
- Data Integration and Analysis

INDIVIDUAL INDENTIFICATION
SPRING RUN

- Individual Identification with High Accuracy
    - 97% accuracy with 17 loci
- More Expensive
    - 17 loci for spring run compared to 7 loci for winter run
- One Year from Now
- Integrate Winter and Spring Run Markers for One Round of Analysis

CONCLUSIONS

- Yes we can use Genetic Characterization and Individual Identification to Estimate Chinook Loss at the SWP/CVP Exports and Track Emigration through the Delta
  - It's just depends on how much we want to spend
- Yes we can estimate loss in real time
  - It just depends on how much we want to spend

CHINOOK SAVED USING EWA ACTIONS

EWA Workshop July 2003, Sheila Greene and Erin Chappell

- Saved based on EWA Case minus Loss based on Base Case
  - assume same loss density
- Relate to population level
  - non-clipped - abundance estimates
  - hatchery - release number

SAVED BASED ON EWA CASE LOSS MINUS LOSS BASED ON BASE CASE

- Assume same population density in Delta adjacent to exports
  - 2002/2003
    - Older Juveniles - 445
    - Fry/Smolts - 24,070
  - 2001/2002
    - Older Juveniles - 5,984
    - Fry/Smolts - 37,307
  - 2000/1999
    - Older Juveniles - 183
    - Fry/Smolts - 15,226

RELATE TO POPULATION LEVEL

- Non-Clipped Chinook
  - relate to abundance estimates

2002/2003 EWA CHINOOK ACTIONS

ACTIONS	DATE(S)	EWA WATER USED (-1) ACQUIRED (+) TAF	NON-CLIPPED CHINOOK						
			OLDER JUVENILE		WINTER RUN			FRY/SMOLT	
			SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX	SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION OF JUVENILE PRODUCTION ESTIMATE (2,136,750)	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX	SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX
EWA Assets to Oroville	10/1/2002 10/6/2003	-4.89	0		0	0.00000		0	
FISH ACTION (CVP)	12/04/02	0.50	0		0	0.00000		0	
FISH ACTION	12/27/2002 01/02/2003	-41.42	371		300	0.00014		0	
FISH ACTION	1/15/2003 1/20/2003	-59.50	195		113	0.00005		54	
FISH ACTION	1/25/2003 1/28/2003	-20.43	100		100	0.00005		0	
E/I RELAXATION & STATE GAIN	3/3/2003 3/31/2003	60.14	-230		-231	-0.00011		-639	
Flood Control Releases (no EWA Cost)	4/2/2003 4/12/2003	-5.03	9		9	0.00000		789	
VAMP	4/15/2003 5/12/2003	-31.77	0		0	0.00000		9256	
SHOULDERS ON VAMP	5/14/2003 5/30/2003	-194.77	0		0	0.00000		14610	
SEASON TOTAL		-297.17	445		291	0.00014		24070	

2001/2002 EWA CHINOOK ACTIONS

ACTIONS	DATE(S)	EWA WATER USED (-1) ACQUIRED (+) TAF	NON-CLIPPED CHINOOK						
			OLDER JUVENILE		WINTER RUN			FRY/SMOLT	
			SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX (257,806)	SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION OF JUVENILE PRODUCTION ESTIMATE (1,991,150)	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX (148,691)	SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX (4,911,278)
Merced & Placer County Water Transfers	10/20/01 11/16/01	22.8	0	0.00000	0	0.00000	0.00000	0	0.00000
E/I Relaxation	11/18/01 11/20/01	24.6	0	0.00000	0	0.00000	0.00000	0	0.00000
Fish Action for Delta Smelt and Chinook	1/05/02 1/09/02	-66.4	119	0.00046	119	0.00006	0.00080	0	0.00000
E/I Relaxation	2/01/02 2/26/02	76.0	-60	-0.00023	-60	-0.00003	-0.00040	0	0.00000
EWA Assets Converted to SWP	3/23/02 3/29/02	-38.1	65	0.00025	65	0.00003	0.00044	227	0.00005
VAMP (including shoulders)	4/15/02 6/02/02	-107.3	59	0.00023	59	0.00003	0.00040	14,999	0.00305
SEASON TOTAL		-88.4	183	0.00071	183	0.00009	0.00123	15,226	0.00310

2000/2001 EWA CHINOOK ACTIONS

ACTIONS	DATE(S)	EWA WATER USED (-1) ACQUIRED (+) TAF	NON-CLIPPED CHINOOK						
			OLDER JUVENILE		WINTER RUN			FRY/SMOLT	
			SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX (358,578)	SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION OF JUVENILE PRODUCTION ESTIMATE (370,200 RBDD) (2,613,700 CARCASS)	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX (212,372)	SAVED AT SWP/CVP SOUTH DELTA EXPORTS	SAVED AS FRACTION CHIPPS ISLAND ABUNDANCE INDEX (7,352,423)
1	1/17/01 1/21/01	-24	0	0.00000	0	0.00000	0.00000	0	0
2	1/27/01 1/31/01	-45	61	0.00017	61	0.00002	0.00029	0	0
3	2/01/01 2/05/01	-17	35	0.00010	35	0.00001	0.00016	0	0
4	2/16/01 2/23/01	-38	1,253	0.00349	1,253	0.00048	0.00590	17.8	0.00000
5	2/27/01 3/11/01	-82	4,635	0.01293	4,619	0.00177	0.02175	204.5	0.00003
6	4/22/01 6/4/01	-56	0	0.00000	0	0.00000	0.00000	37084.1	0.00504
SEASON TOTAL		-206	5,984	0.01669	5,968	0.00228	0.02810	37306.4	0.00507

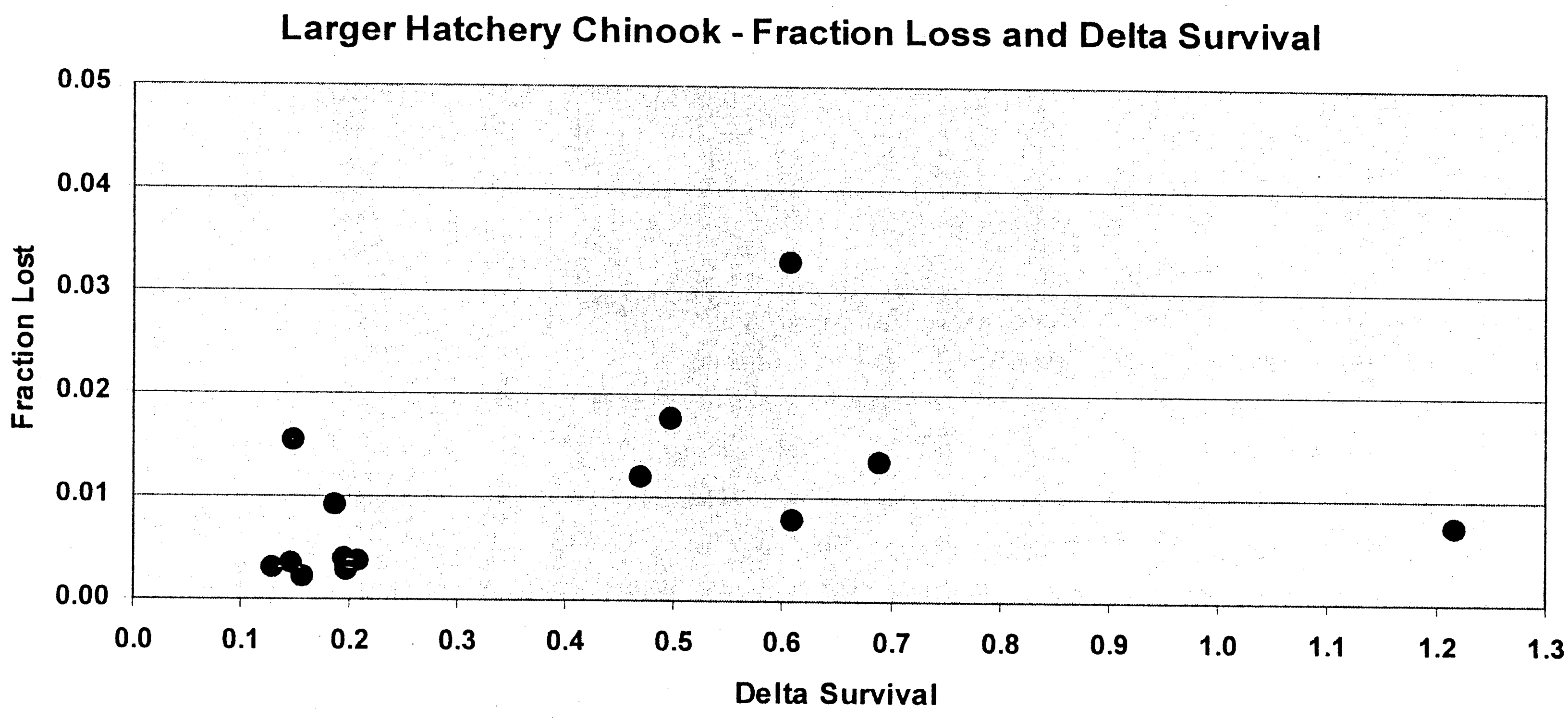
RELATE TO POPULATION LEVEL

- **Non-Clipped Chinook**
  - relate to abundance estimates
- **Hatchery**
  - relate to release number

EWA CHINOOK ACTIONS 2000/2001 THROUGH 2002/2003

Late Fall and Winter Hatchery Chinook

RELEASE U - Upstream D - Delta LF - Late Fall WR - Winter Run	NUMBER RELEASED	LOSS AT SWP/CVP SOUTH DELTA EXPORTS WITH EWA ACTIONS	SAVED AT SWP/CVP SOUTH DELTA EXPORTS WITH EWA ACTIONS	FRACTION LOSS WITH EWA ACTIONS	FRACTION SAVED WITH EWA ACTIONS	CHIPPS ISLAND SURVIVAL INDEX
U-Nov-2002-LF	71,082	202	0	0.0028	0.0000	0.197
U-Dec-2002-LF	62,709	756	46	0.0121	0.0007	0.469
U-Jan-2003-LF	76,672	1,037	90	0.0135	0.0012	0.691
U-Jan-2003-LF	540,198	17,784	7,145	0.0329	0.0132	0.608
U-Jan-2003-WR	233,879	580	-28	0.0025	-0.0001	
D-Dec-2003-LF	72,010	1,262	347	0.0175	0.0048	0.497
D-Dec-2003-LF	143,493	2,209	431	0.0154	0.0030	0.149
U-Nov-2001-LF	88,039	194	0	0.0022	0.0000	0.158
U-Dec-2001-LF	73,856	676	0	0.0092	0.0000	0.187
D-Dec-2001-LF	130,897	1,405	-69	0.0107	-0.0005	
U-Jan-2002-LF	65,237	480	-26	0.0074	-0.0004	1.218
U-Jan-2002-LF	538,226	4,173	-68	0.0078	-0.0001	0.610
U-Jan-2002-WR	252,684	50	0	0.0002	0.0000	
D-Nov-2000-LF	109,873	386	66	0.0035	0.0006	0.146
U-Dec-2000-LF	54,568	147	27	0.0027	0.0005	
D-Jan-2001-LF	156,457	465	256	0.0030	0.0016	0.130
U-Jan-2001-LF	65,284	235	6	0.0036	0.0001	0.208
U-Jan-2001-LF	365,153	1,421	422	0.0039	0.0012	0.196
U-Feb-2001-WR	162,396	54	15	0.0003	0.0001	0.104


Larger Hatchery Chinook - Fraction Loss and Delta Survival

slg

Use and Appropriateness of the Available Statistical Tools in Assessing and Quantifying Fish Mortality in the Delta

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What is Covered

- Vernalis Adaptive Management Plan (VAMP) Mark-Recovery Data
- Late fall mark-recovery data
- Review of Newman's paper on modeling of paired release-recovery data

Three sets of data collected to assess the possible effects of water exports on salmon smolt survival.

Vernalis Adaptive Management Plan (VAMP) Mark-Recovery Data

Expected Numbers

	Number	Recovered	Number	Recovered
Upstrm Release	R_u			
	↓			
Downstream	R_uS		R_d	
	↓		↓	
Recoveries A/CI	R_uSS_1	→ $R_uS\pi$	R_dS_1	→ $R_d\pi$

R_u, R_d = numbers released
S = survival rate to downstream
S_1 = survival rate further downstream to Antioch/Chips Island
π = survival and recovery rate, downstream to Antioch/Chips Island
Highlight = what we can estimate, or know.

- Comparison of the recoveries from upstream and downstream releases makes it possible to estimate the survival rate S (from upstream to downstream), which may be affected by exports.

Year	Surv	SE	Flow	Exports	Flow/Exp
1994	0.130		2468	1671	1.477
1997	0.186		5905	2302	2.565
2000	0.186	0.019	6020	2155	2.794
2001	0.190	0.014	4220	1420	2.972
2002	0.151	0.013	3300	1430	2.308

Correlation Matrix

	Surv	Flow	Exports	Flow/Exp
Surv	1.00	0.86	0.42	**0.95**
Flow		1.00	**0.80**	0.73
Exports			1.00	0.17
Flow/Exp				1.00

- It appears that survival is most correlated with Flow/Exports

Regressions

$$\text{Surv} = 0.104 + 1.47\times10^{-5}(\text{Flow})$$
$$R^2 = 0.74$$
$$t = 2.91 \text{ for flow coefficient, } p = 0.062$$

Better using log(Flow) according to Figure 5.10 of VAMP 2002 report ($R^2 = 0.81$, $p < 0.05$).

$$\text{Surv} = 0.146 + 2.46\times10^{-5}(\text{Flow}) - 4.77\times10^{-5}(\text{Exports})$$
$$R^2 = 0.94$$
$$t = 4.89 \text{ for flow coefficient, } p = 0.039$$
$$t = -2.48 \text{ for exports coefficient, } p = 0.131$$

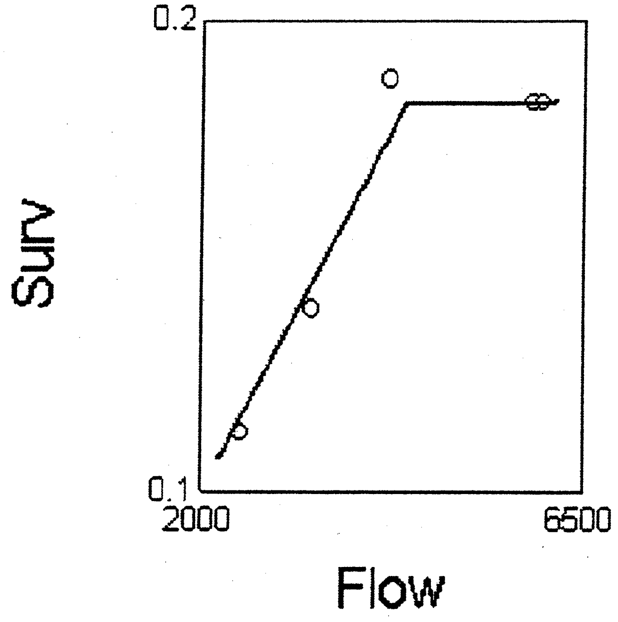
$$\text{Surv} = 0.120 + 2.70\times10^{-5}(\text{Exports})$$
$$R^2 = 0.17$$
$$t = 0.79 \text{ for exports coefficient, } p = 0.487$$

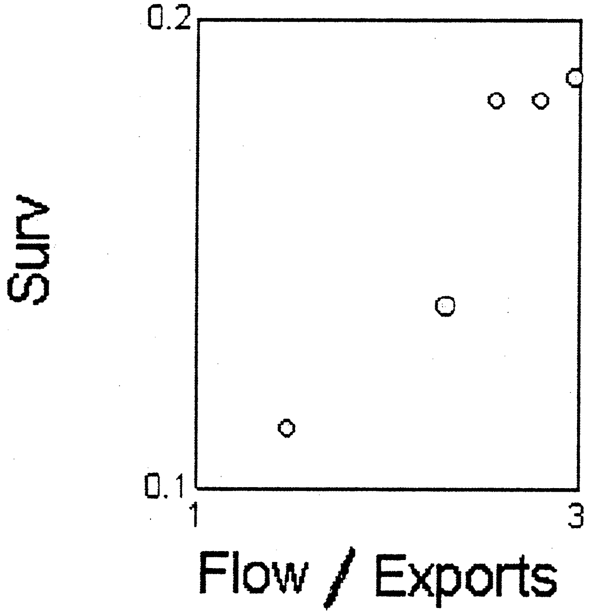
$$\text{Surv} = 0.064 + 0.043(\text{Flow/Exports})$$
$$R^2 = 0.90$$
$$t = 5.08 \text{ for coefficient of flow/exports, } p = 0.015$$

Strange: why should doubling the flow and the exports not improve survival?

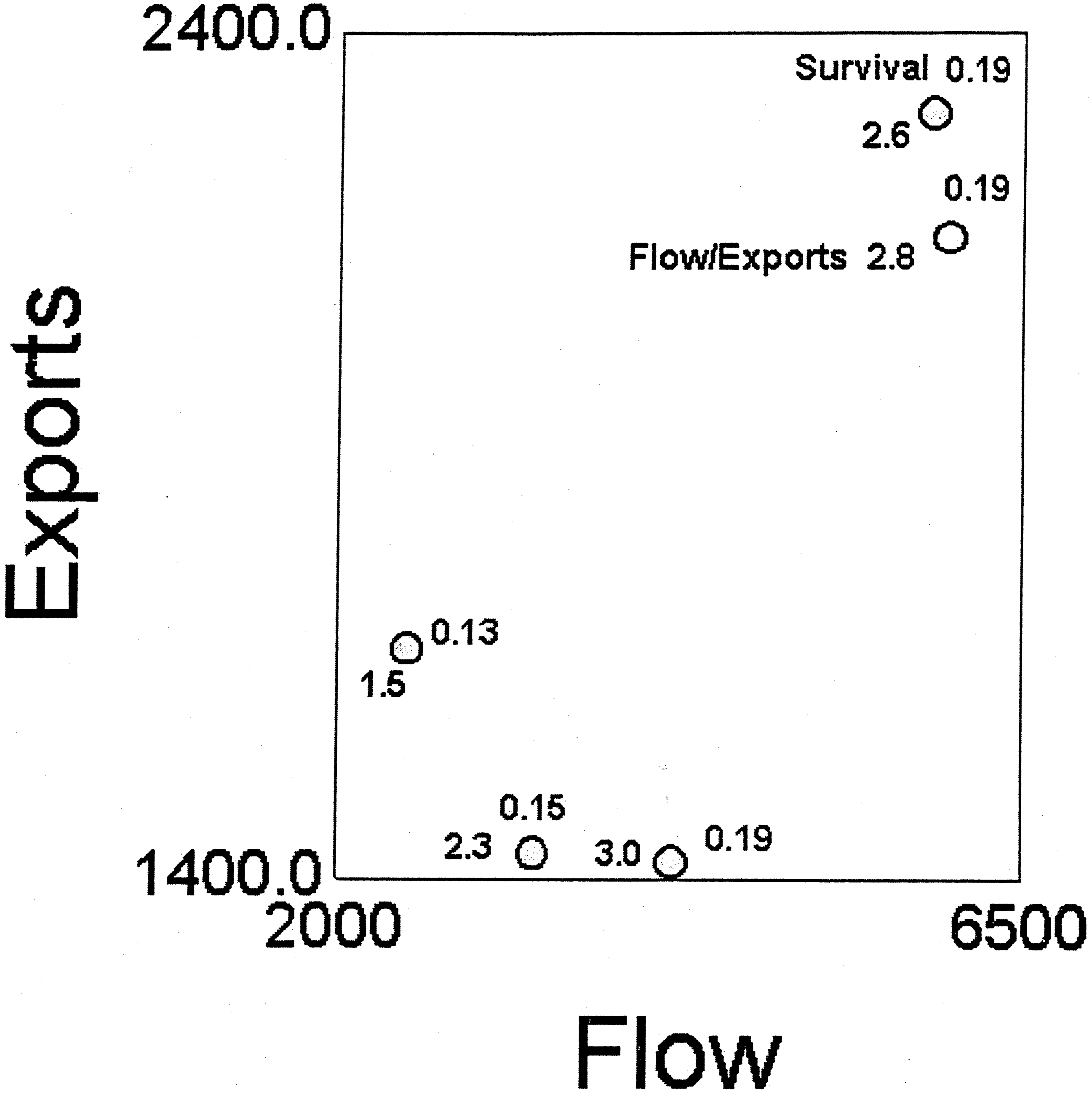
Possible Limiting Effects

- Not enough data to say anything for sure!





What if the relationship between survival and flow is not a simple linear one?



Top two points have a lot more flow than the middle one and relatively slightly more exports but the estimated survival is about the same.

Conclusions

- The relationship between survival, flow and exports is almost certainly not a simple linear one.
- Five data points are just not enough to draw any clear conclusions about what is going on.
- The correlation between exports and flow is making it difficult to separate their effects.

Late Fall Mark-Recovery Data

- Similar in design to the VAMP experiment, with results from upstream releases of salmon smolt into the north end of the Georgiana Slough (possibly affected by exports), and downstream releases at Ryde or Isleton (assumed not to be affected by exports).
- Allows the estimation of the survival of the salmon smolt from upstream to where the downstream releases occur.

Variables

Surv	Estimated survival upstream to downstream
Temp	Average water temperature during experiment
TempCh	Maximum temperature change per day during experiment.
ExAv3	Average exports in 3 days following release day, with similar definitions of ExAv5, ExAv7 and ExAv17.
ExAv3a	Average exports from CVP + Clifton Court inflows for 3 days following release day, with similar definitions for EzAv5a, ExAv7a and ExAv17a.
GSFAv3	Georgiana Slough flow average for 3 days following release, with similar definitions for GSFAv5, GSFAv7 and GSFAv17.
SFAv3	Sacramento River at Ryde flow average for 3 days after release, with similar definitions for SFAv5, SFAv7 and SFAv17.

				SWP + CVP Export rates (cfs)			CCFB Inflow + CVP Exports (cfs)			Georgiana Slough Flow (cfs)			Sacramento River at Ryde Flow (cfs)		
Date	Surv	Temp	TempCh	ExAv3		ExAv17	ExAv3a		ExAv17a	GSFAv3		GSAv17	SRAv3		SRAv17
Dec-93	0.144	10.3	-0.08	10435	...	10535	9810	...	10555	2753	...	3748	8138	...	13427
Dec-94	0.273	8.8	-0.18	5988	...	7255	6143	...	7281	4615	...	3302	18937	...	13279
Jan-95	0.155	9.7	0.29	10403	...	11675	10995	...	11877	4322	...	9572	25759	...	58713
Jan-96	0.256	9.6	-0.33	9523	...	10594	9545	...	10675	3161	...	5255	14141	...	29776
Dec-97	0.047	9.7	-0.19	10570	...	10859	10395	...	10817	3622	...	4044	18448	...	20092
Jan-98	0.275	9.4	-0.50	3887	...	4276	3928	...	4324	9425	...	10262	59572	...	61284
Dec-98	0.243	9.7	-0.40	1848	...	2151	1956	...	2267	7364	...	8181	46105	...	47035
Dec-98	0.719	7.1	-0.20	1916	...	2610	2089	...	2669	3817	...	3466	17956	...	16063
Dec-99	0.160	9.0	-0.12	3780	...	3671	2405	...	3620	3192	...	3013	14318	...	10177
Dec-99	0.667	8.9	-0.10	3870	...	8369	3739	...	8582	2855	...	2805	8657	...	8366
Jan-02	0.327	10.6	-0.29	7833	...	9856	5589	...	10105	9125	...	7240	55023	...	37203

Correlations

	Surv	Temp	TempCh	ExAv3		ExAv17	ExAv3a		ExAv17a	GSFAv3		GSAv17	SRAv3		SRAv17
Surv	1.00	**-0.68**	-0.10	**-0.61**	...	-0.37	**-0.57**	...	-0.35	-0.05	...	-0.27	-0.10	...	-0.27
Temp		1.00	-0.01	**0.62**	...	**0.57**	**0.51**	...	**0.58**	0.32	...	0.40	0.33	...	0.36
TempCh			1.00	0.44	...	0.49	0.47	...	0.49	**-0.57**	...	-0.15	**-0.53**	...	-0.13
ExAv3				1.00	...	**0.93**	**0.97**	...	**0.93**	-0.27	...	0.04	-0.25	...	0.05
ExAv5						**0.95**	**0.98**	...	**0.94**	-0.32	...	0.01	-0.30	...	0.03
ExAv7						**0.97**	**0.97**	...	**0.97**	-0.30	...	0.03	-0.29	...	0.04
ExAv17						**1.00**	**0.91**	...	**1.00**	-0.29	...	-0.02	-0.29	...	-0.02
ExAv3a							**1.00**	...	**0.90**	-0.33	...	0.08	-0.30	...	0.10
ExAv5a									**0.95**	-0.30	...	0.05	-0.29	...	0.07
ExAv7a									**0.98**	-0.25	...	0.07	-0.24	...	0.08
ExAv17a									**1.00**	-0.28	...	-0.01	-0.28	...	-0.00
GSFAv3										**1.00**	...	**0.75**	**0.99**	...	**0.70**
GSAv5											...	**0.81**	**1.00**	...	**0.77**
CSAv7												**0.90**	**0.98**	...	**0.86**
GSAv17												**1.00**	**0.81**	...	**0.99**
SRAv3													**1.00**	...	**0.77**
SRAv5														...	**0.85**
SRAv7															**0.93**
SRAv17															**1.00**

Points to Note

- Survival is moderately negatively correlated with Temp (r = -0.68), ExAv3 (r = -0.61), and ExAv3a (r = -0.57).
- Highest correlation with flow variables is with 17 day averaging.
- Temperature is moderately positively correlated with the export variables.
- The export variables are all quite highly correlated.
- The flow variables are high to very highly correlated.
- For simplicity further analyses just considered Temp, TempCh, ExAv3 and SRAv17.

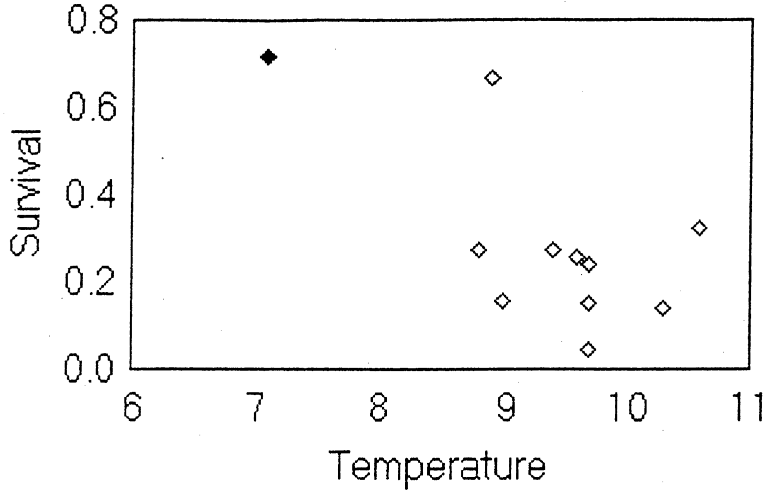
Regressions

- Simple regressions give a significant negative relationship between Surv and Temp ($p = 0.021$) and ExAv3 ($p = 0.048$), but quite insignificant results for TempCh and SRAv17.

- If ExAv3 is added to the equation with Temp already in then the improvement in fit is fairly minor (R^2 changes from 0.462 to 0.518). This is not at all significant ($F = 0.94$ with 1 and 8 df, $p = 0.361$).

- Apparently temperature is the important variable (but temperature is correlated with exports).

- But one data point seems to have a lot of influence.


0.8
0.6
0.4
0.2
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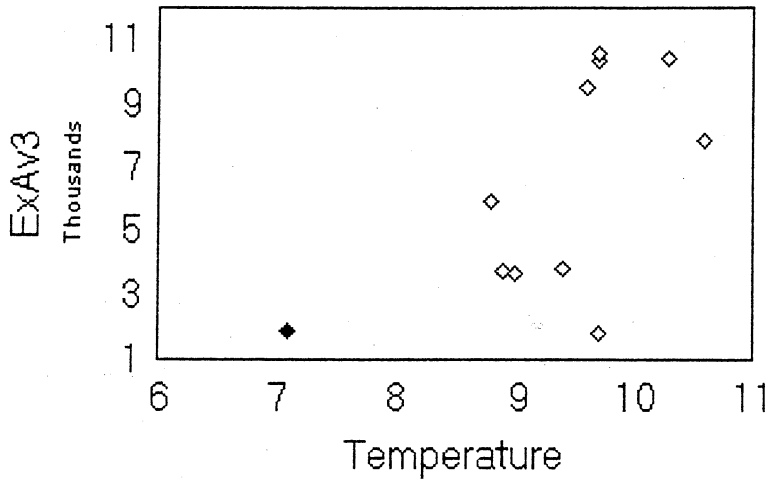
Survival
6
7
8
9
10
11
Temperature


11
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ExAv3
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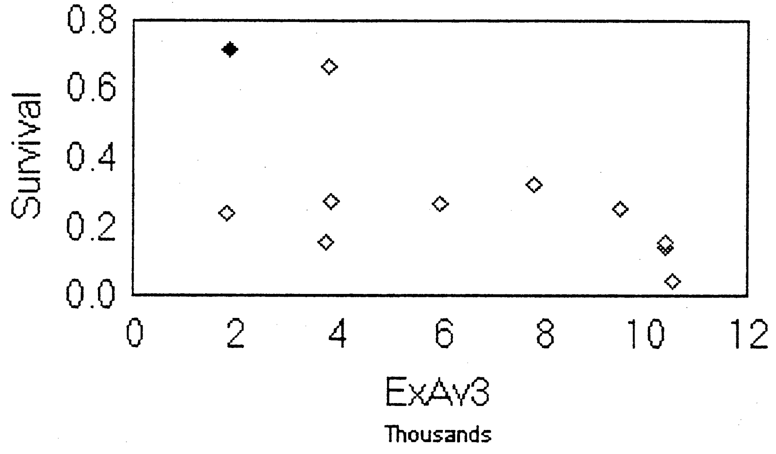
Temperature


0.8
0.6
0.4
0.2
0.0
Survival
0
2
4
6
8
10
12
ExAv3
Thousands

Conclusions

- Flow rates and temperature changes do not seem very important for the survival from north of Georgiana Slough to downstream.
- Apparently the correlation between exports and survival may be accounted for by temperature effects, but one data point seems crucial.
- Clear evidence for an effect of exports seems lacking at present.

Review of Newman's Paper on Modeling of Paired Release-Recovery Data

Expected Numbers

	Number	Caught	Number	Caught
Upstream	R_u			
	↓			
Downstream	R_uS	→ R_uSp	R_d	
	↓		↓	
Ocean	$R_uS(1\text{-}p)S_1$	→ $R_uS(1\text{-}p)\pi$	R_dS_1	→ $R_d\pi$

R_u, R_d = numbers released
S = survival rate to downstream, p = recovery rate downstream
S_1 = survival rate downstream to ocean
π = survival and recovery rate, downstream to ocean.
Highlight = what we can estimate, or know.

Three Methods of Analysis Used

- "Standard" maximum likelihood approach.
- Pseudo-likelihood approach designed to overcome some of the problems with the standard method.
- Bayesian hierarchical model, also designed to overcome some problems with the standard approach.
- Survival probabilities (S) related to 11 covariates (size of fish, log flow rate, etc.) using a standard logistic model approach.
- Simple models used for downstream recovery probability (p): depends on sampling effort, or just different for 1988 (year with high effort).

Standard Model (TBP)

- Multinomial distributions for counts of recovery numbers, combined for all release pairs.
- Assumes all animals behave independently with same survival and capture probabilities and recovery counts are exact - counts definitely not exact for ocean recoveries.
- Estimates may be okay, but variances will be too small.

Conclusion: Could be okay if the variances were estimated properly.

Pseudo-Likelihood Approach

- Assumes that the expected numbers recovered are as for the standard method, but variances are inflated by factors ϕ_{ut} (upstream trawl recovery), ϕ_{u0} (upstream ocean recovery), and ϕ_{do} (downstream ocean recovery).
- Ocean recovery numbers are estimated by a stratified sample of marine catch - variances for estimates should be available. Why not used with ϕ_{uo} and ϕ_{do}?
- In practice ϕ_{do} was set at 1.0 (clearly not right), and ϕ_{ut} sometimes had to be set at 1.0 (maybe okay).
- Variance inflation factors very large (e.g., 84 in one case), leading to very large SE.

Conclusion: This model needs more work on it. I suspect that the variances are too large and the variance inflation factors are not right.

Bayesian Hierarchical Model

- Start with assumptions about prior distributions for unknown distributions and modify these based on the observed data using **Bayes' theorem** (standard result in probability theory).

- Prior distributions should be decided **before the data are looked at** (should be independent of the data for Bayes' theorem to apply).

- An **axiomatic** approach because you start with some assumptions that cannot be checked.

- For the release-recovery data the prior distributions have to be guessed - only God knows the real ones.

- Some of the distributions are questionable, e.g. the estimated ocean catch $\hat{y}_{do}$ is definitely not binomially distributed (equation 3.5) because it is an estimated count - may be some sort of reasonable approximation.

- Sensitivity analysis needed to find out how the results of the analysis depend on the prior distributions.

- Cross-validation results not surprising - even if a model is quite wrong an analysis can give consistent results while still giving very biased estimates. Not a real test of robustness.

Conclusion: If you accept that the prior distributions and the model are correct, then you can believe the results - otherwise, it is not clear what you should think about them. Needs more work to assess the robustness to assumptions.

Overall Conclusions About the 3 Models

The numerical values of parameter estimates may be generally reasonable, but the standard errors and hence the significance of the estimates is questionable for all three models.

Overall Conclusions About the 3 Data Sets

There are some problems with all of these analyses:

- Correlation between flow and exports is clouding the picture for analysis 1. Probably some real experimental perturbations to the system are needed to clarify what is going on.

- Temperature seems to account for survival variation without any export effects with analysis 2, but one data point may be responsible for this, with the lowest temperature, the lowest exports and the highest estimated survival. Again some experimental manipulations may be required to properly assess the effects of exports.

- All the models for analysis 3 have questionable aspects in terms of assessing the statistical significance of the effects of covariates on survival.