RC 4

ALASKA BOARD OF FISHERIES

Upper Cook Inlet Finfish
Oral Reports

Board Meeting
February 1–12, 2008
Anchorage, Alaska

Oral Reports

Escapement Goal Review for Salmon Stocks in Upper Cook Inlet

James J. Hasbrouck
Lowell F. Fair
Robert A. Clark

Written: RC 3; Tab 1
Oral: RC 4; Color Tab 1

http://www.sf.adfg.state.ak.us/FedAidPDFs/fms07-06.pdf

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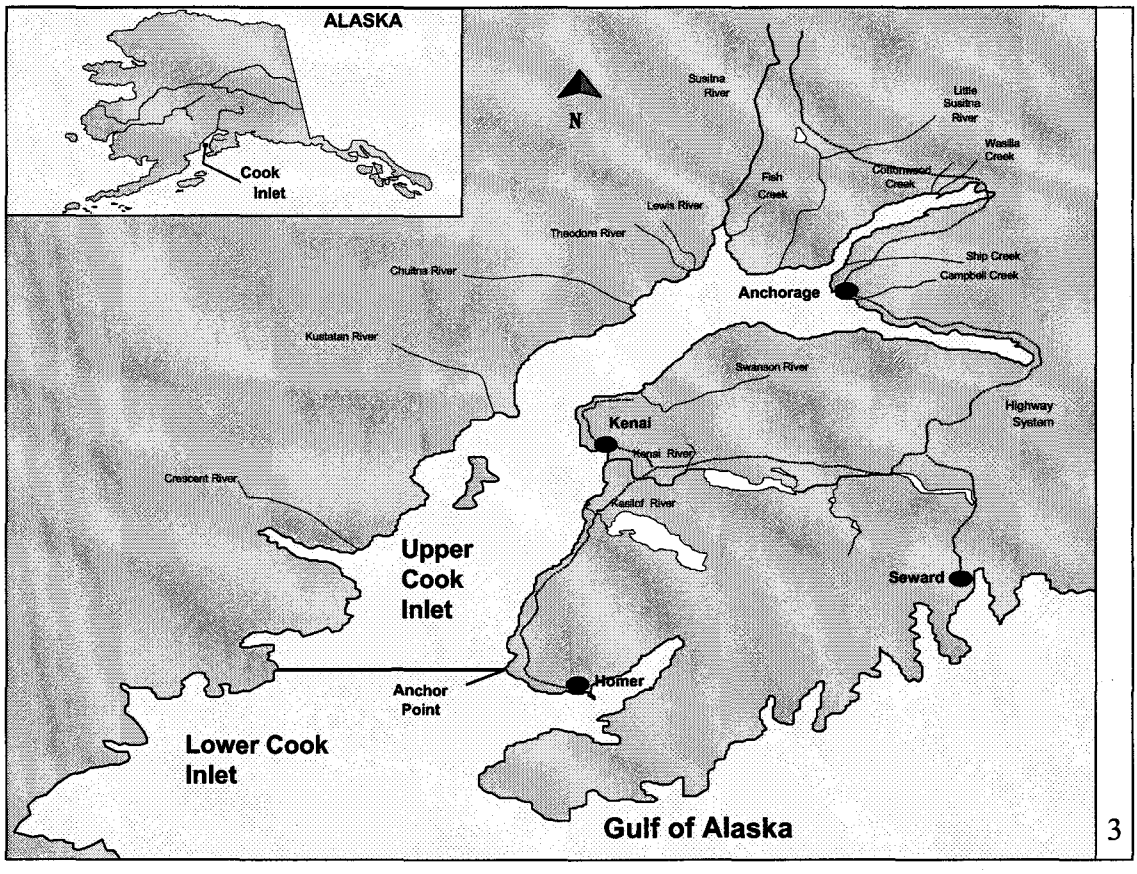

3

Review Escapement Goals

- 34 salmon stocks have goals – 22 Chinook, 1 chum, 3 coho, 8 sockeye
- Review based on the Sustainable Salmon Fisheries Management (5 AAC 39.222) and Statewide Salmon Escapement Goal (5 AAC 39.223) policies

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Escapement Goal Review Process

- Update escapement & (when possible) return data of all stocks
- Review current goal, both type & range, & recommend any changes to goals based on evaluation of updated data
- Present goal recommendations to directors of both fisheries divisions for approval

Biological Goal (BEG)

- Scientifically defensible estimates of escapement providing greatest potential for maximum sustained yield (MSY); escapement producing MSY (S_{msy})
- Methodology – Spawner-Return Model; Yield Analysis
- Escapement, Harvest & Age Data

Sustainable Goal (SEG)

- Escapement that is known to provide sustained yield over 5-10 year period
- Methodology – Percentile Approach
- Most stocks - Only escapement data available; total return & yield?

7

Chinook Salmon

- Campbell Creek – Re-instate SEG = 50-700
- Eagle River-South Fork – Remove SEG
- Remaining 20 stocks – No change

8

Sockeye Salmon

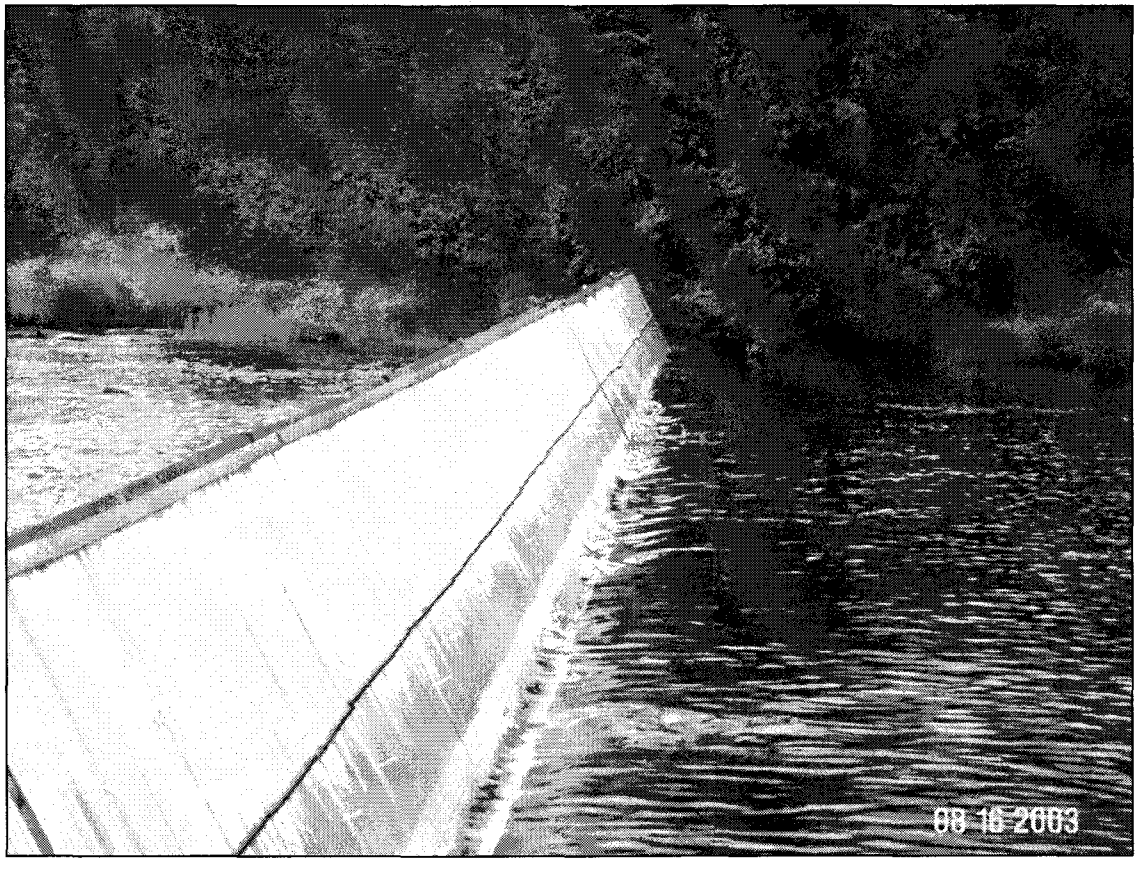
- Packers Creek – Re-instate SEG = 15,000-30,000
- Remaining 7 stocks – No change

Coho Salmon

- Campbell Creek – Remove SEG
- Remaining 2 stocks – No change

Conclusions

- Reviewed 34 escapement goals
- Recommended changes - Re-instate 2 goals and remove 2 goals



Biological and Fishery-Related Aspects of Overescapement in Alaskan Sockeye Salmon

Alaska Board of Fisheries
Upper Cook Inlet Regulatory Meeting
Anchorage, Alaska
1 February 2008

Oral – RC 4, Tab 2
Written – RC 3, Color Tab 2

Robert Clark
Mark Willette
Steve Fleischman
Doug Eggers

Alaska Department of Fish and Game
Divisions of Sport and Commercial Fisheries

Biological and Fishery-Related Aspects of Overescapement in Alaskan Sockeye Salmon

- **Background**
  - Policies and Definitions
  - Generic Theory of Production
  - Hypotheses Concerning Density Dependence
- **Examples from Alaskan Sockeye Salmon**
  - Methods
  - Biological Aspects
  - Fishery-Related Aspects
- **Conclusions**
- **Recommendations**

Background - Policies and Definitions

Providing for sustained yield:

Constitution:
Article VIII, Sec(4). Fish, forests, wildlife, grasslands, and all other replenishable resources belonging to the State shall be utilized, developed, and maintained on the **sustained yield principle**, subject to preferences among beneficial uses.

Statute:
AS 16.05.020(2). The commissioner (of the Department of Fish and Game) shall manage, protect, maintain, improve and extend the fish, game and aquatic plant resources of the state in the interest of the economy and general well-being of the state.

Background - Policies and Definitions

Providing for sustained yield:

Regulation:
- Management plans for salmon fisheries
- Mixed-Stock Salmon Policy, 5 AAC 39.220
- Sustainable Salmon Fisheries Policy, 5 AAC 39.222
- Escapement Goal Policy, 5 AAC 39.223

Sustainable Salmon and Escapement Goal Policies:
- Manage for escapement goals
- Biological Escapement Goal (BEG) and Maximum Sustained Yield (MSY)
- Sustainable Escapement Goal (SEG) and Sustained Yield

Background - Policies and Definitions

Definitions:

- **Overescapement** = escapements that are above the range of the current escapement goal

Background - Policies and Definitions

Definitions:

Fishery-Related Effects	Biological Effects
Based on year of fishery	Based on brood year
Run or Total Run	Return or Total Return
Harvest Rate	Exploitation Rate
Harvest	Yield
Realized Escapement	Brood Year Escapement
Harvest ÷ Run = Harvest Rate Run – Harvest = Escapement	Yield ÷ Return = Exploitation Rate Return – Escapement = Yield

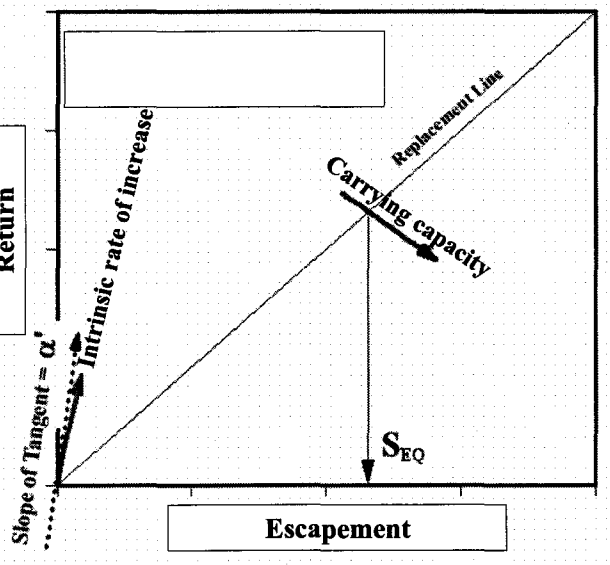
Background – Generic Theory of Production

Intrinsic rate of increase (α')

- density independent
- species & regionally specific

Carrying capacity (S_{EQ})

- density dependent
- watershed specific



Background – Generic Theory of Production

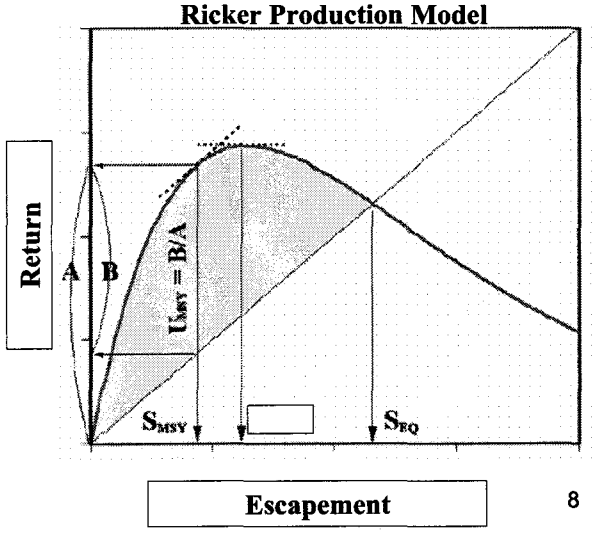
Sustained Yields = green shaded area

S_{MSY} = escapement that produces MSY

MSY = maximum sustained yield (B)

μ_{MSY} = exploitation rate at MSY (B/A)

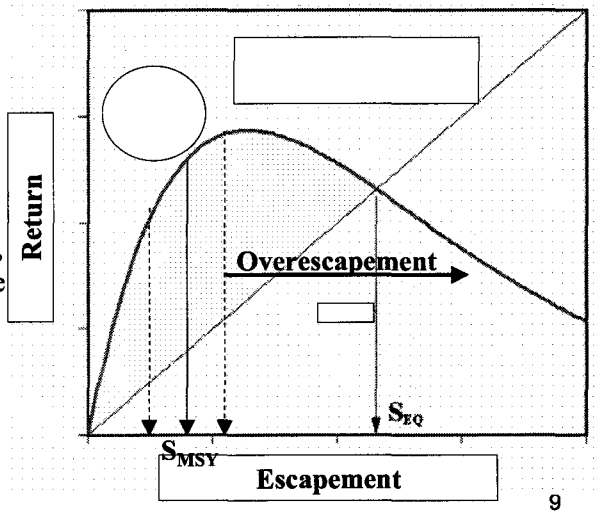
S_{EQ} = carrying capacity



Background – Generic Theory of Production

Overescapement - escapements that are above the range of the current escapement goal.

If we know S_{MSY} and set an EG around it, we should see **yields decrease** on average when overescapement occurs.



Background – Hypotheses Concerning Density Dependence

Short term effects – single brood

- During spawning – egg retention, spawning failure, redd superimposition
- During egg stage – smothering of redds, marginal spawning habitat
- During fry stage – predation, parasitism, starvation overwinter
- During smolt stage – predation, transition to seawater, food availability

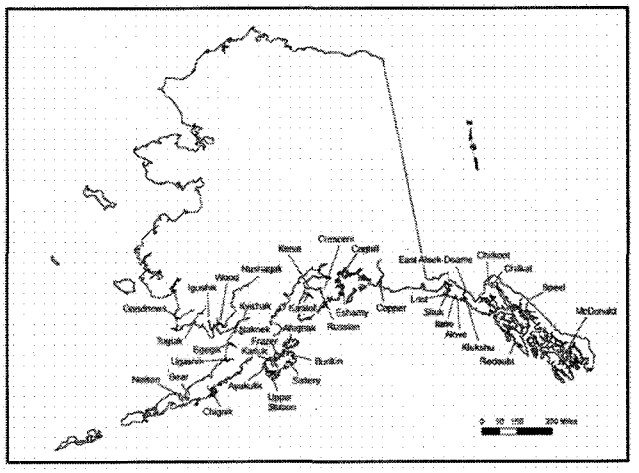
Longer term effects – subsequent broods

- During egg stage – high density affects future egg survival
- During juvenile stages – increased parasite loading, increased predators, increased grazing on zooplankton
- **Delayed density dependence**

Examples from Alaskan Sockeye Salmon

Methods:

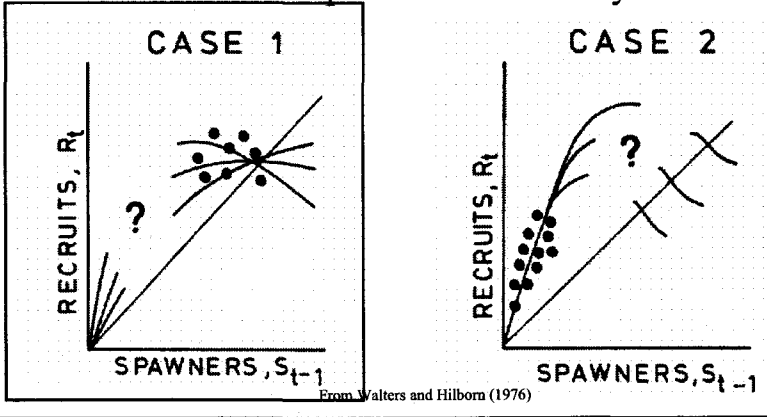
- 40 stocks
- All regions of AK
- BEGs & SEGs
- Data from published brood tables
- Compared using same production model



Examples from Alaskan Sockeye Salmon

Methods:

- Reliable estimate of carrying capacity from Ricker model
- Reliable estimate depends on the history of fishing



From Walters and Hilborn (1976)

Examples from Alaskan Sockeye Salmon

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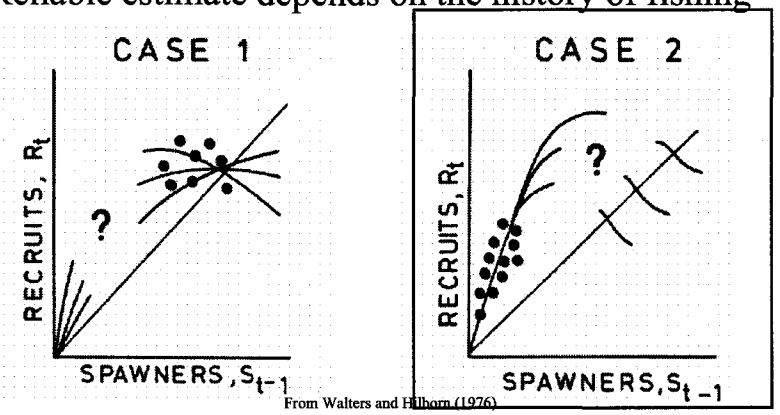
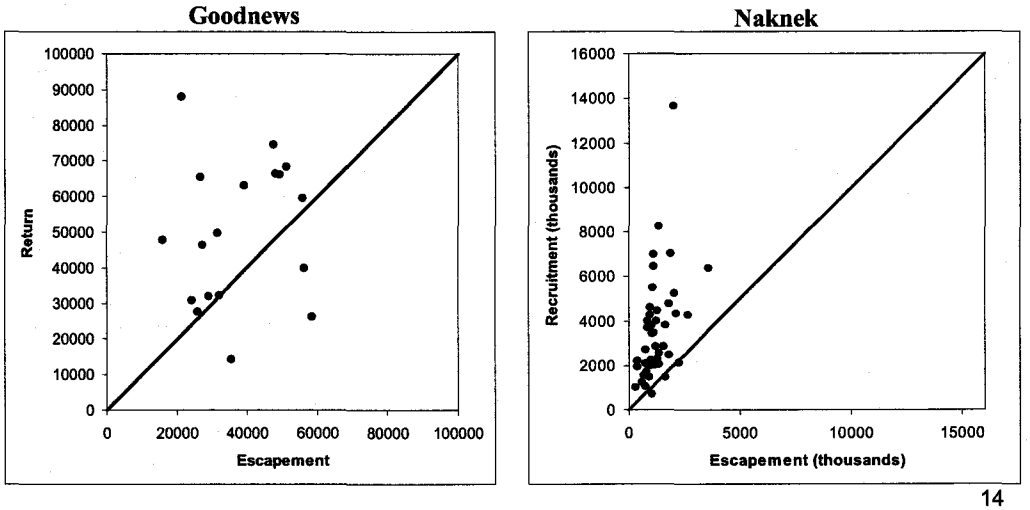


From Walters and Hilborn (1976)

Examples from Alaskan Sockeye Salmon



Examples from Alaskan Sockeye Salmon

Metrics of overescapement:

- Percentage of escapements at or exceeding carrying capacity
- Yields relative to MSY and Escapements relative to S_{MSY}
- Average yields within and above escapement goal
- Variation in yields within and above escapement goal
- Evidence of delayed density dependence
- Percentage of years of overescapement
- Foregone harvest
- Foregone harvest as a percentage of the run

Examples from Alaskan Sockeye Salmon

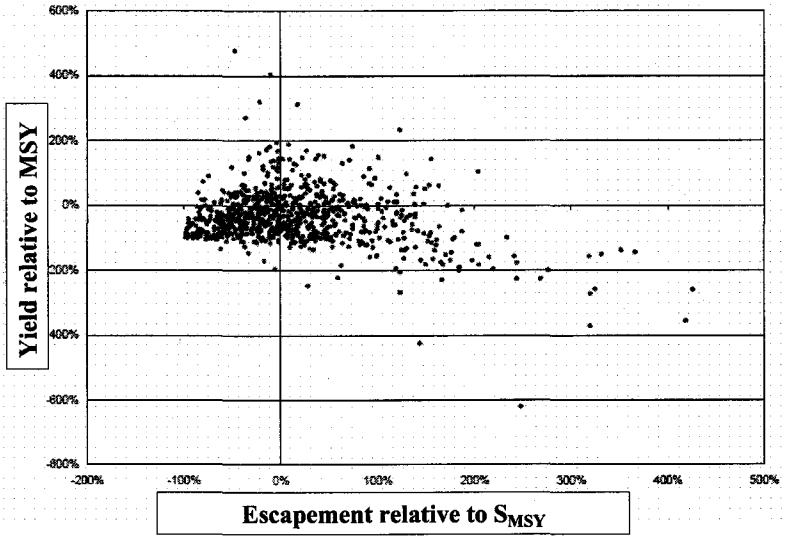
Biological Aspects of Overescapement:

Reliable estimate of carrying capacity for 29 of 40 stocks

- Escapements exceeded carrying capacity in some stocks
- Yields fell below MSY as escapements exceeded S_{MSY}
- Average yields decreased
- Variation in yields increased

Examples from Alaskan Sockeye Salmon

Yields relative to MSY and escapements relative to S_{MSY}



22 of 29 stocks showed a decrease in yields when overescapement occurred.

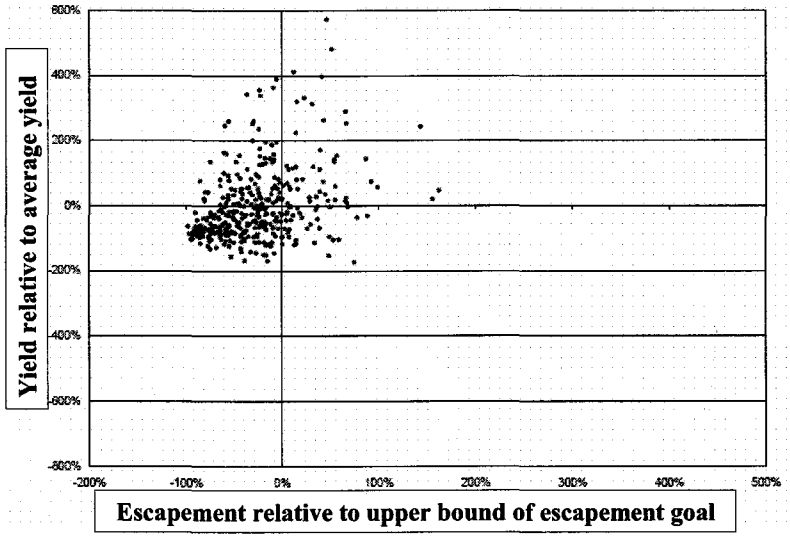
Examples from Alaskan Sockeye Salmon

Biological Aspects of Overescapement:
Could not reliably estimate carrying capacity for 11 of 40 stocks

- Average yields increased
- Variation in yields decreased slightly

Examples from Alaskan Sockeye Salmon

Yields relative to average and escapements relative to upper bound

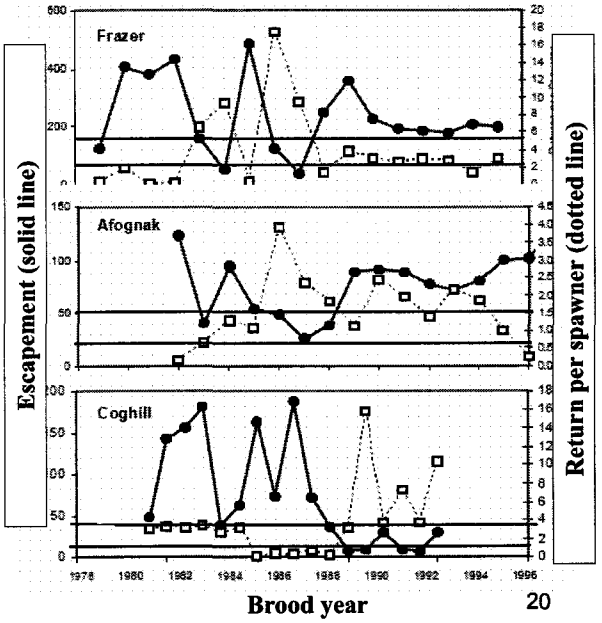


7 of 11 stocks showed an increase in yields when overescapement occurred.

Examples from Alaskan Sockeye Salmon

Delayed Density Dependence

- R/S below replacement in 3 of 5 stocks
- Reduced R/S in remaining 2 of 5 stocks



Examples from Alaskan Sockeye Salmon

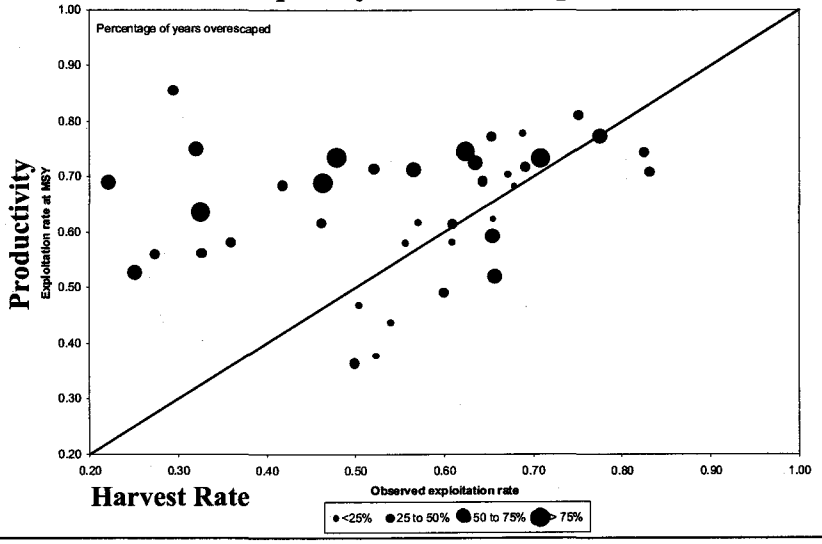
Fishery-Related Aspects of Overescapement:

- Overescapement occurred in 37 of 40 stocks
  - ranged from 0% to 93% of the time
- Foregone harvest occurred in 37 of 40 stocks
  - ranged from 0 fish to 686,500 fish
- Foregone harvest ranged from 0% to 32% of run

Examples from Alaskan Sockeye Salmon

Fishery-Related Aspects of Overescapement:

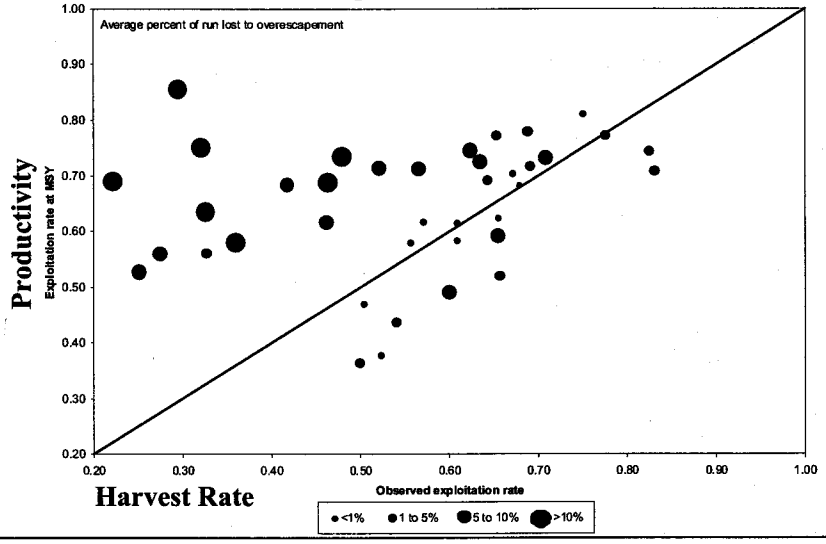
- Frequency of overescapement



Examples from Alaskan Sockeye Salmon

Fishery-Related Aspects of Overescapement:

- Percentage of run forgone to overescapement



Conclusions

Overescapement:

- Occurred at least once in 37 of 40 sockeye stocks
- 29 of 40 stocks – average yields decreased, variation in yields increased
- 11 of 40 stocks – average yields increased, variation in yields similar
- Evidence for delayed density dependence in 3 of 5 stocks
- Foregone harvest occurred in 37 of 40 stocks
- Foregone harvest averaged 0 to 686,500 fish
- Percentage of run foregone ranged from 0% to 32%

Recommendations

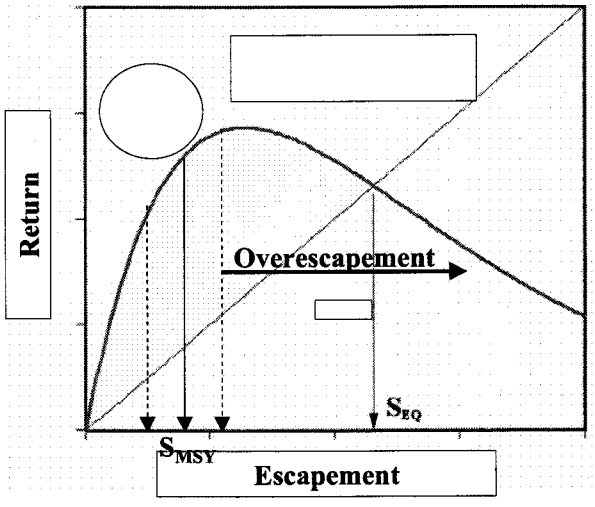
Research

- Develop and validate methods to determine carrying capacity
- Integrated models to test hypotheses of density dependence

Management

- Improved preseason forecasting of run strength
- Improved inseason assessment of run strength
- Study economic effects of overescapement

Questions?



UPPER COOK INLET

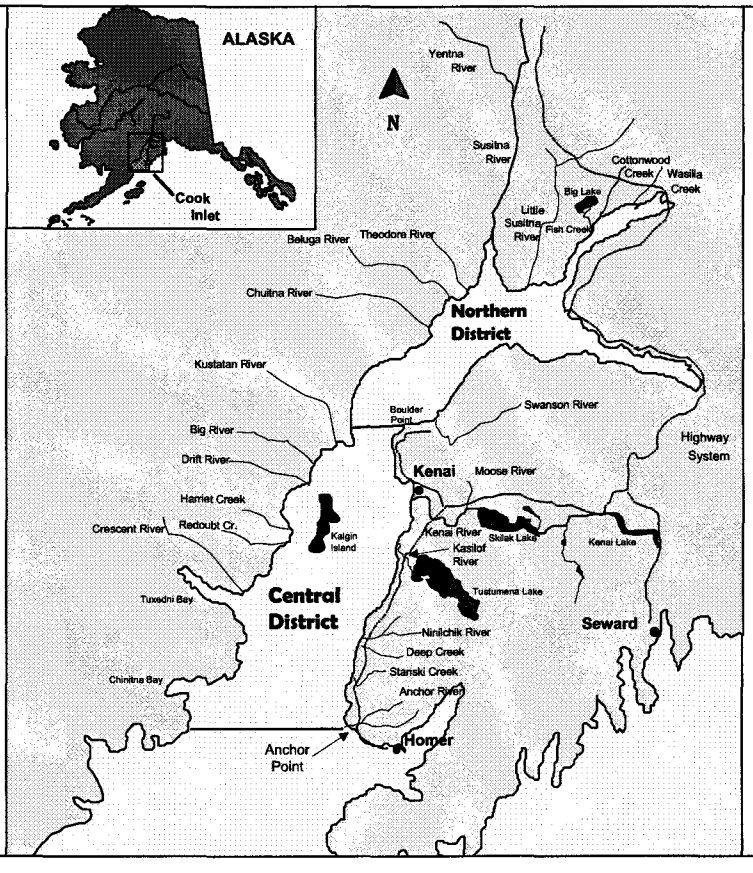
Commercial Fisheries Management Report

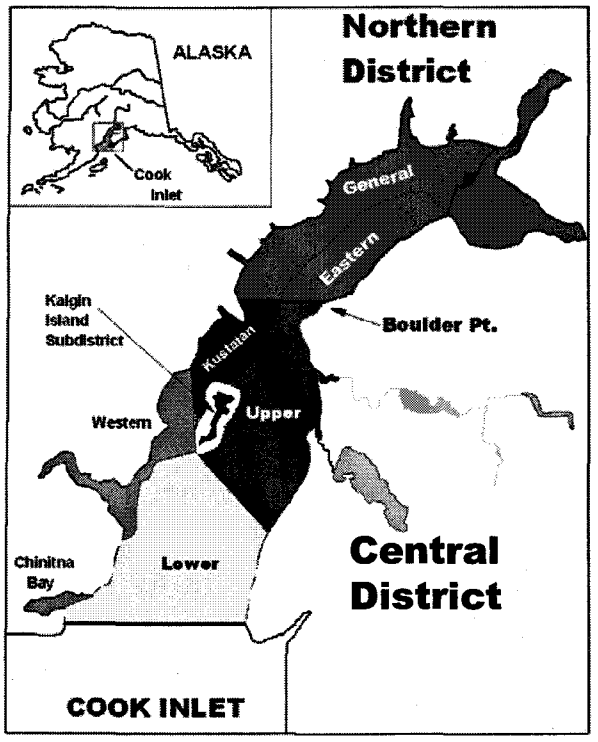
Commercial Fisheries Division

Report to the Alaska Board of Fisheries

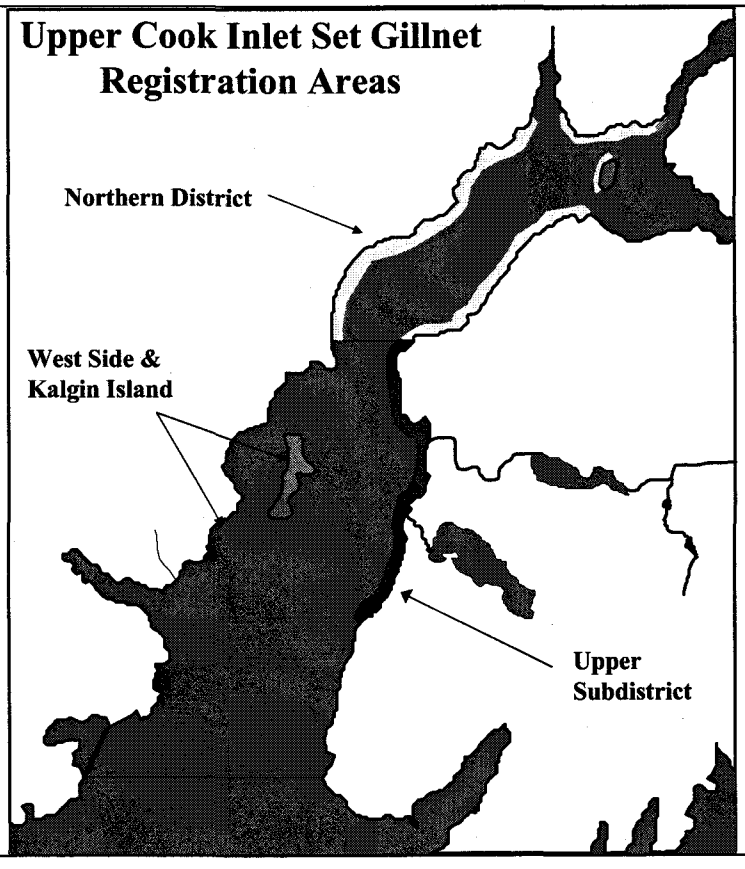
February 2008

by Pat Shields

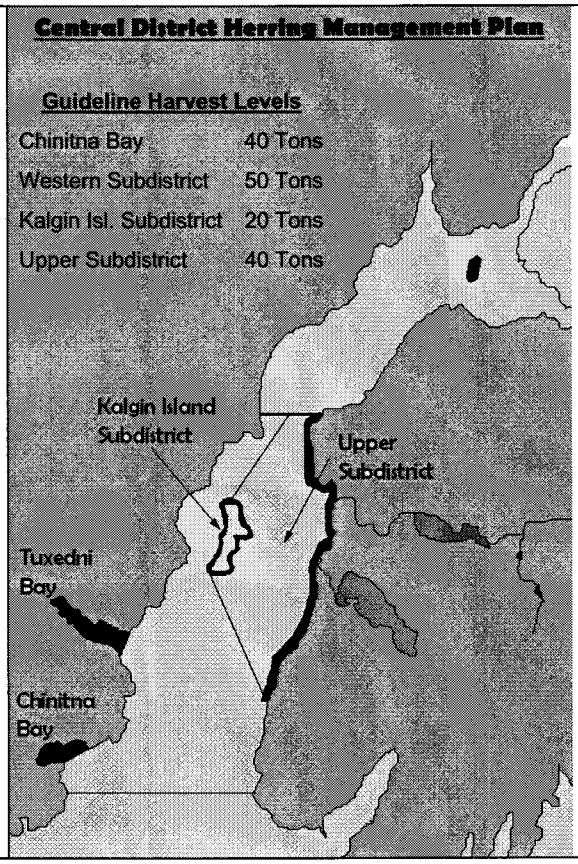



ALASKA
Cook Inlet
Northern District
General
Eastern
Kalgin Island Subdistrict
Kustatan
Boulder Pt.
Western
Upper
Chinitna Bay
Lower
Central District
COOK INLET

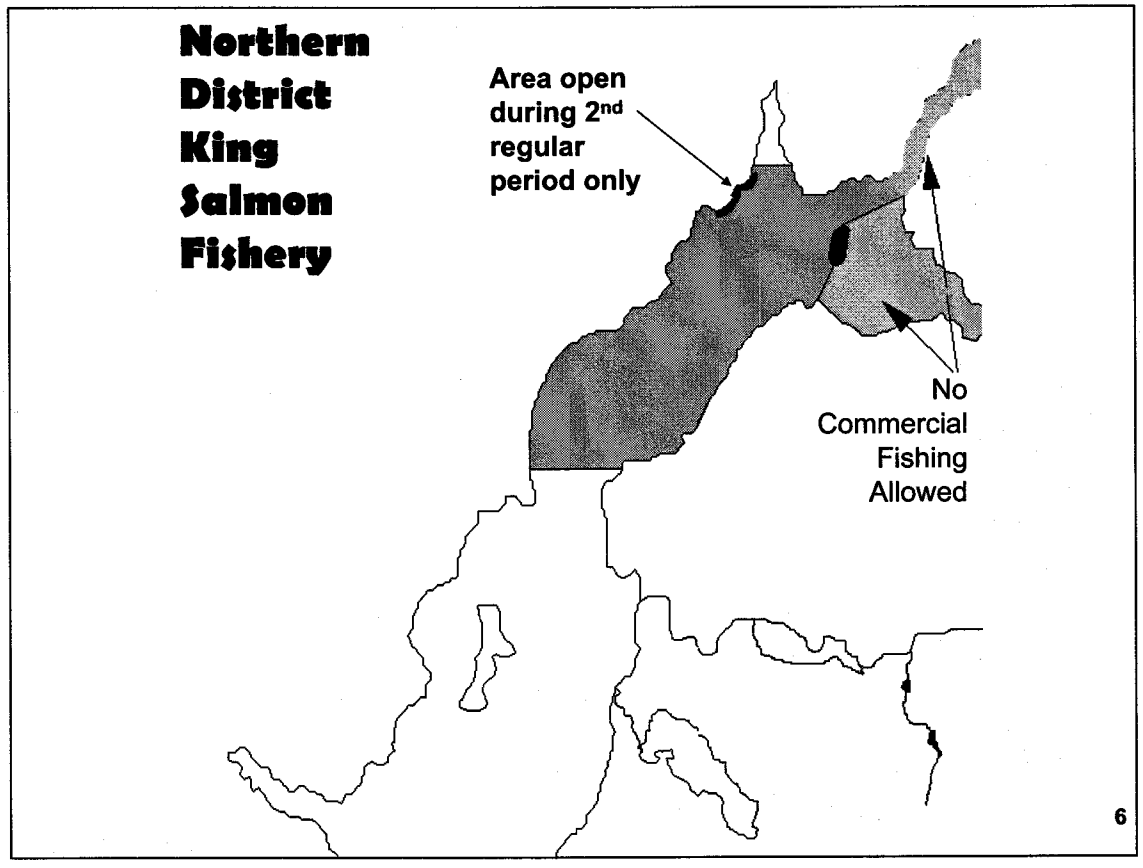
3


Upper Cook Inlet Set Gillnet Registration Areas
Northern District
West Side & Kalgin Island
Upper Subdistrict

4

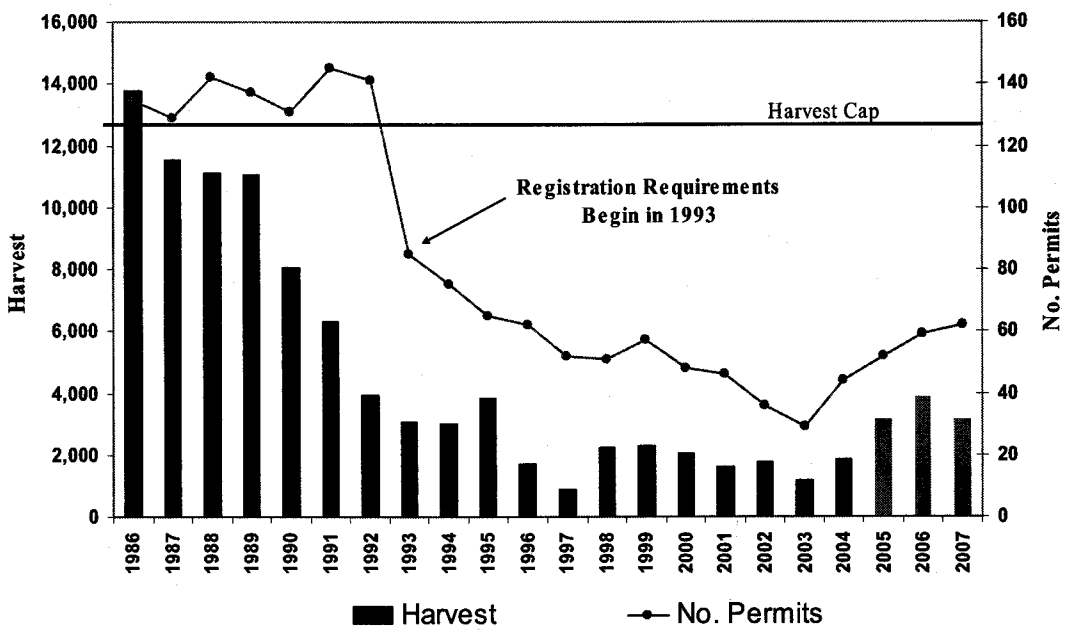

Central District Herring Management Plan
Guideline Harvest Levels
Chinitna Bay 40 Tons
Western Subdistrict 50 Tons
Kalgin Isl. Subdistrict 20 Tons
Upper Subdistrict 40 Tons
Kalgin Island Subdistrict
Upper Subdistrict
Tuxedni Bay
Chinitna Bay

5


Northern District King Salmon Fishery
Area open during 2nd regular period only
No Commercial Fishing Allowed

6

Northern District King Salmon Fishery



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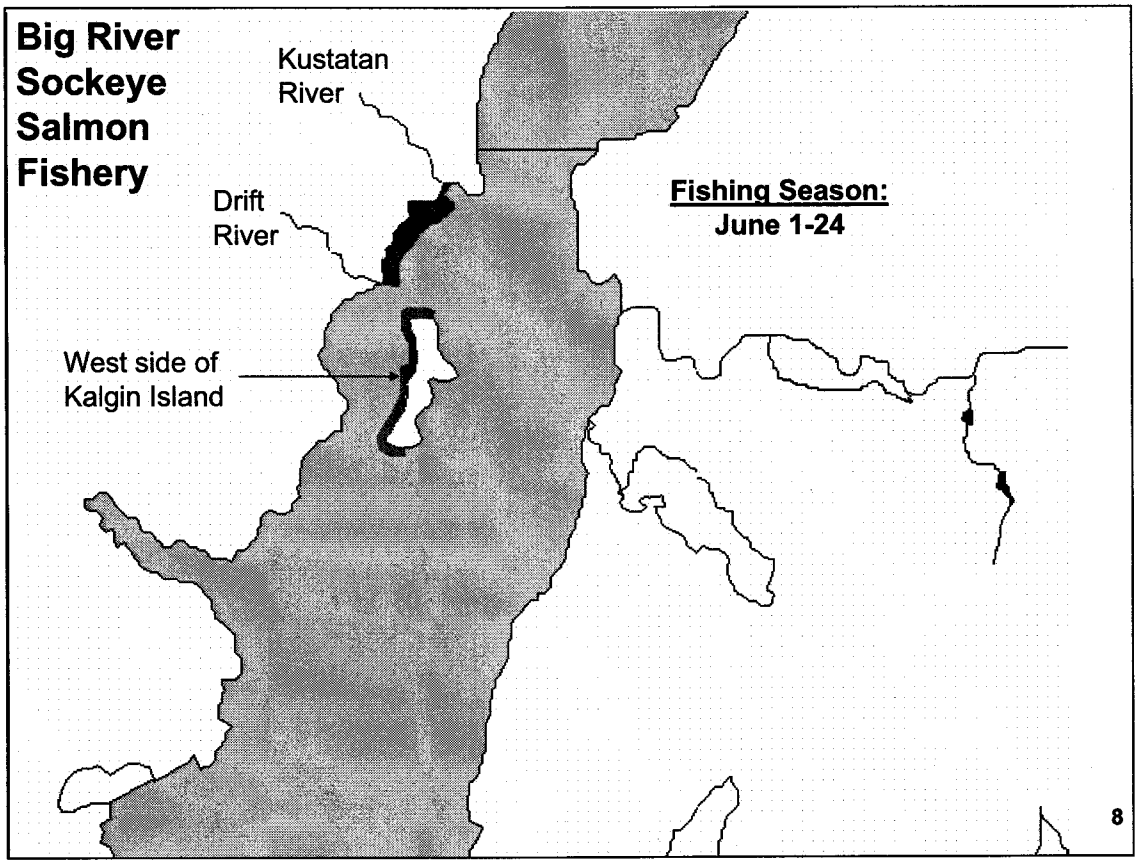
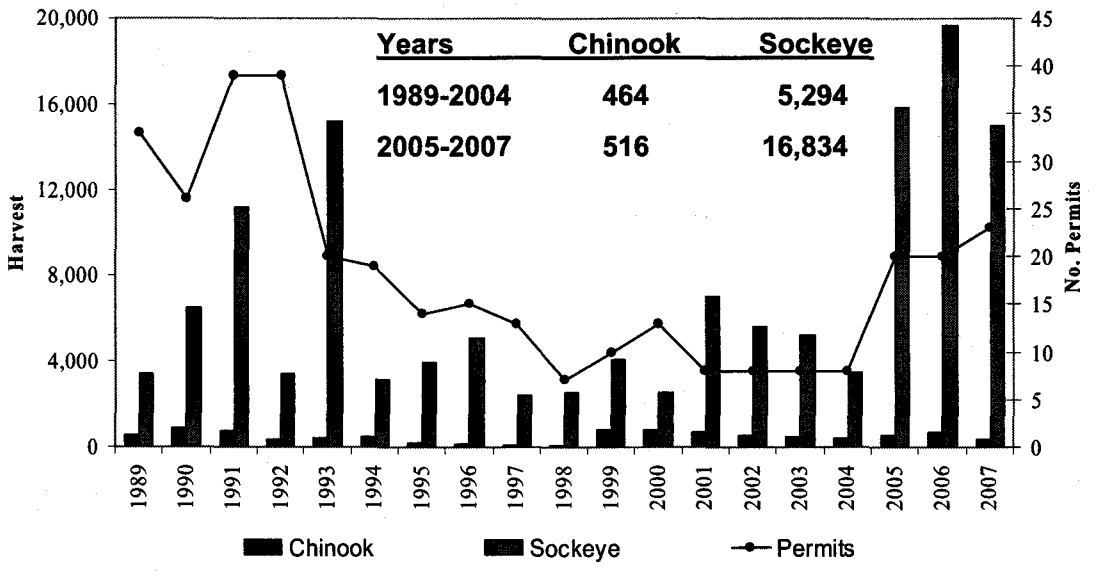
Big River Sockeye Salmon Fishery

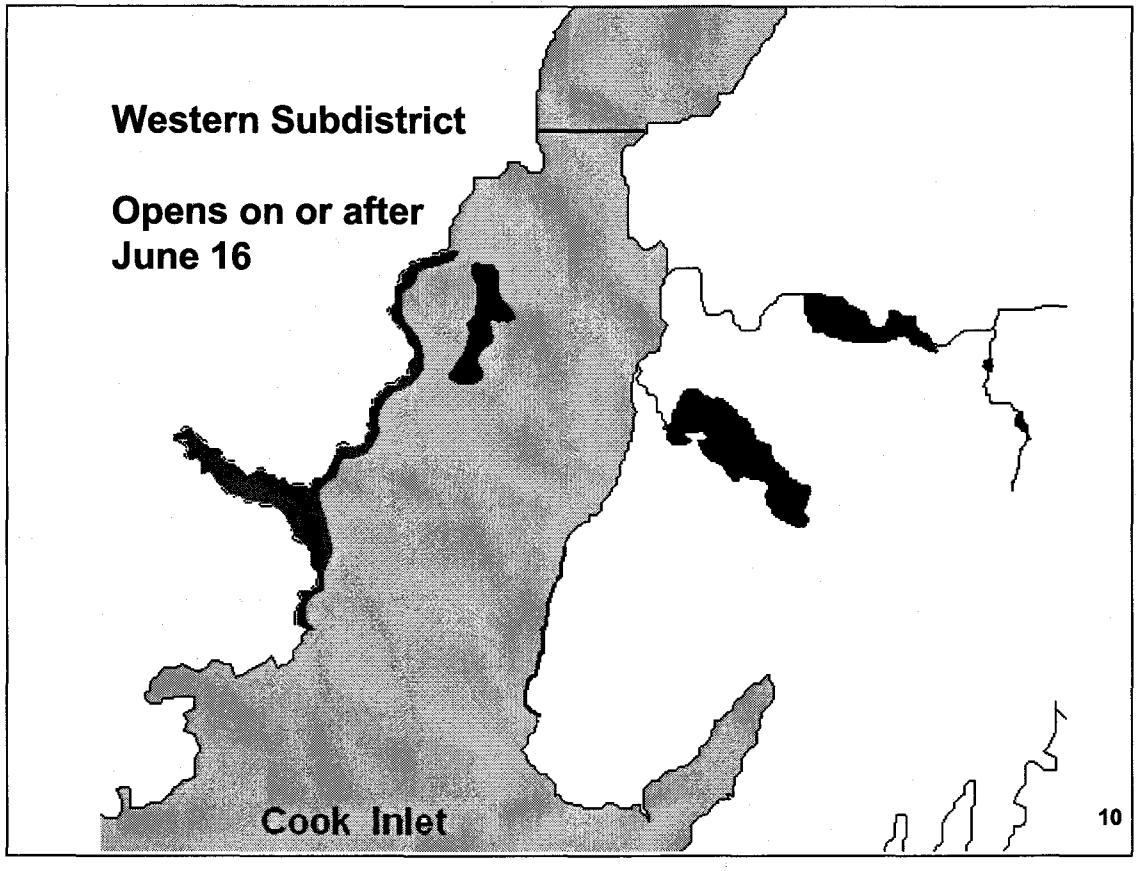


8

Big River Sockeye Salmon Fishery



9



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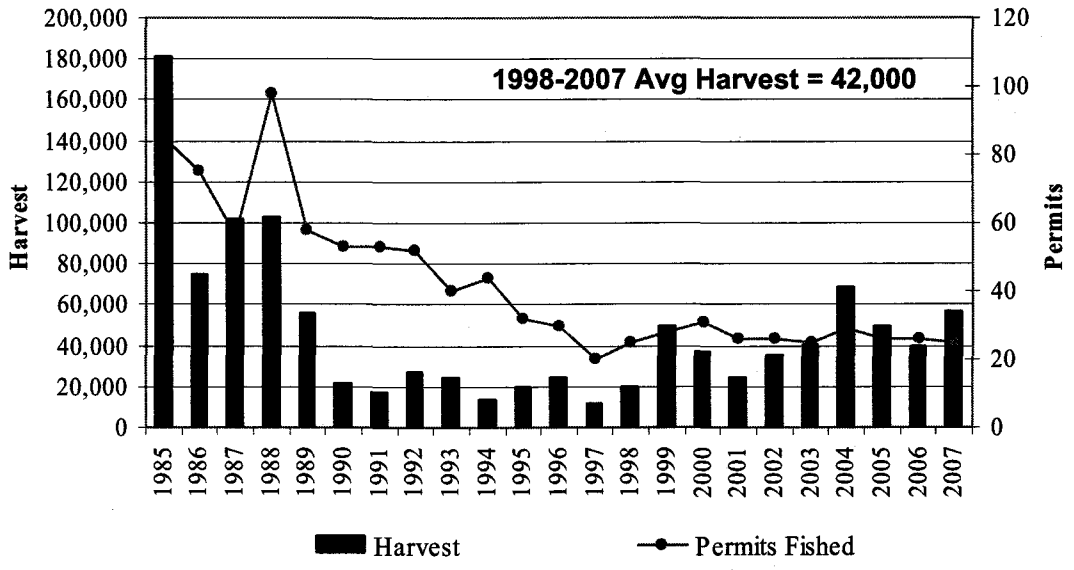
Western Subdistrict Sockeye Salmon Harvest



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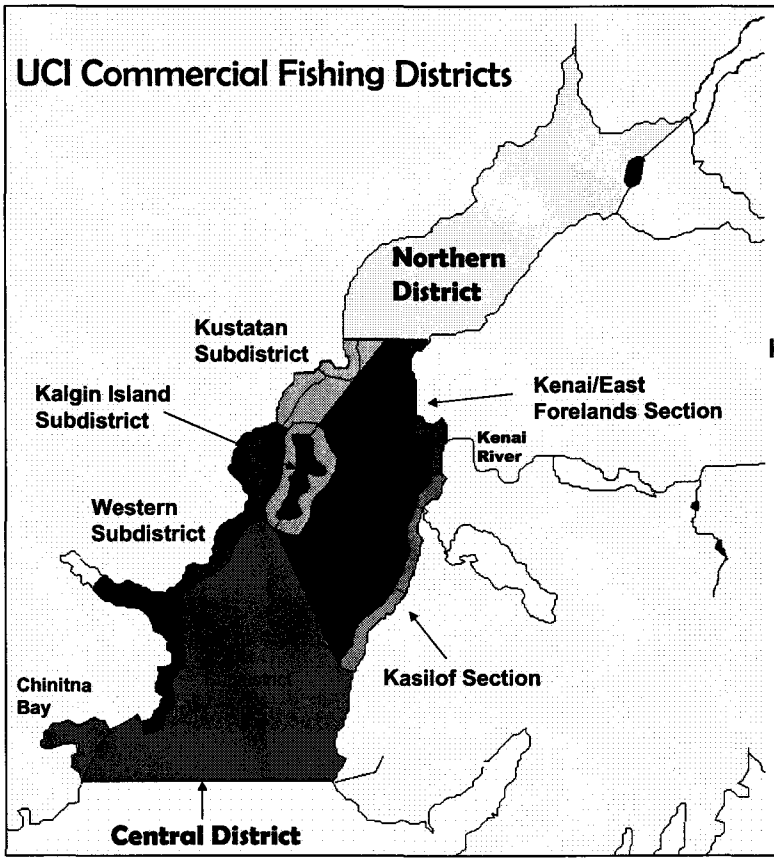
UCI Commercial Fishing Districts



Commercial Fishing Opening Dates
(earliest date possible)

Western SubDistrict: Jun 16

Drift Gillnet: June 19

Kasilof Section (set): Jun 20

All others: June 25

Kenai – E. Forelands: Jul 8

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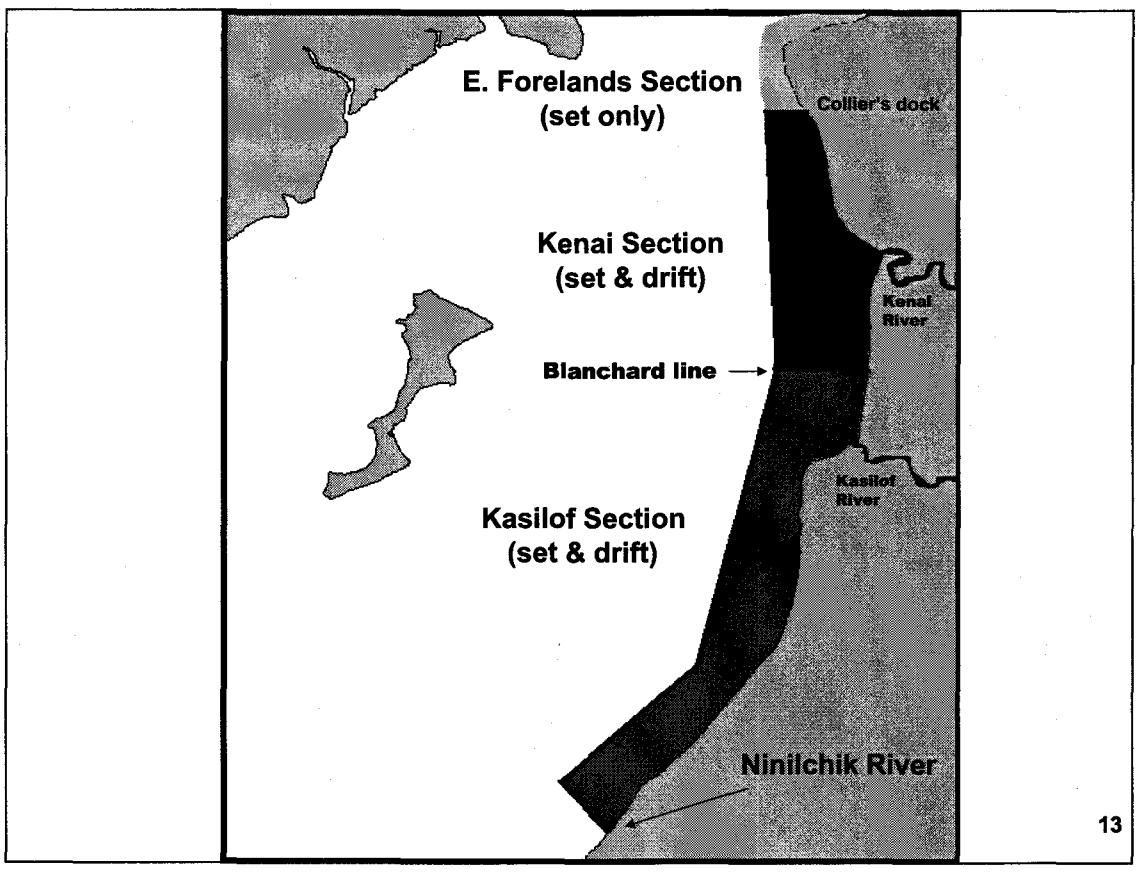
E. Forelands Section
(set only)
Collier's dock
Kenai Section
(set & drift)
Kenai River
Blanchard line
Kasilof River
Kasilof Section
(set & drift)
Ninilchik River

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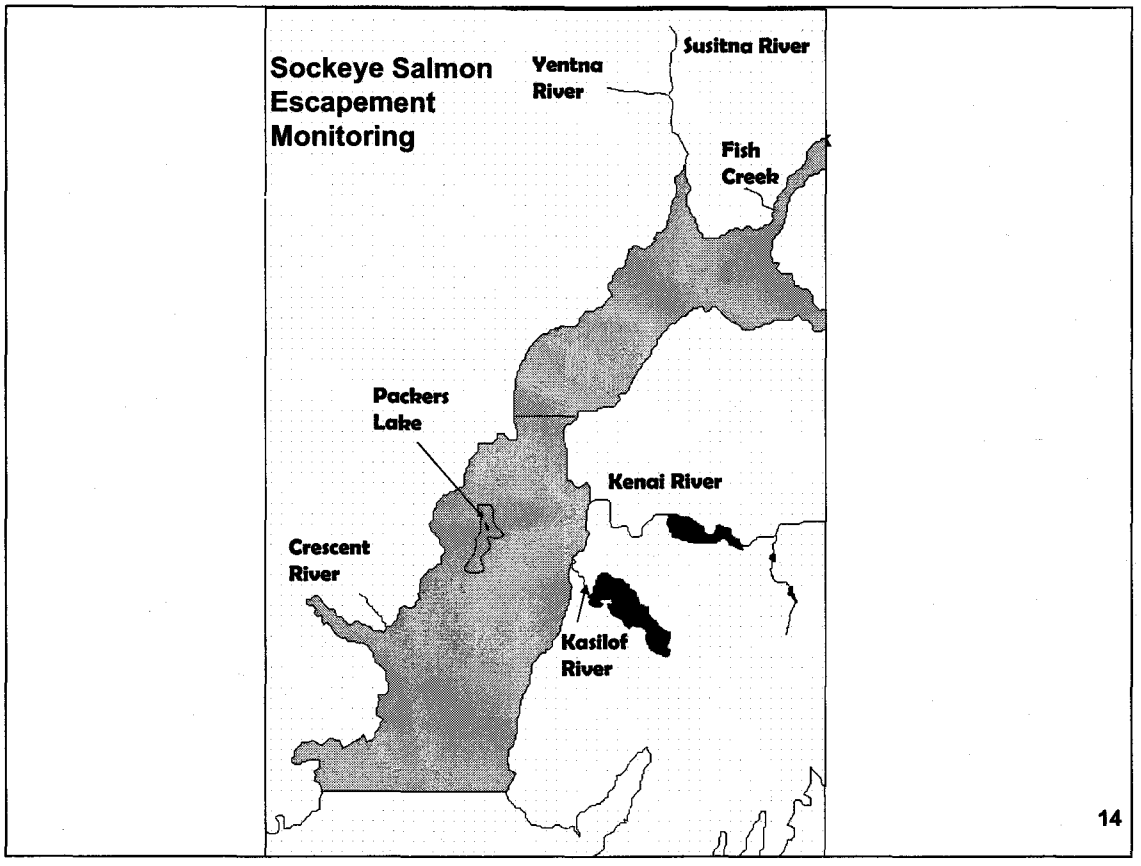

Sockeye Salmon
Escapement
Monitoring
Yentna River
Susitna River
Fish Creek
Packers Lake
Kenai River
Crescent River
Kasilof River

14

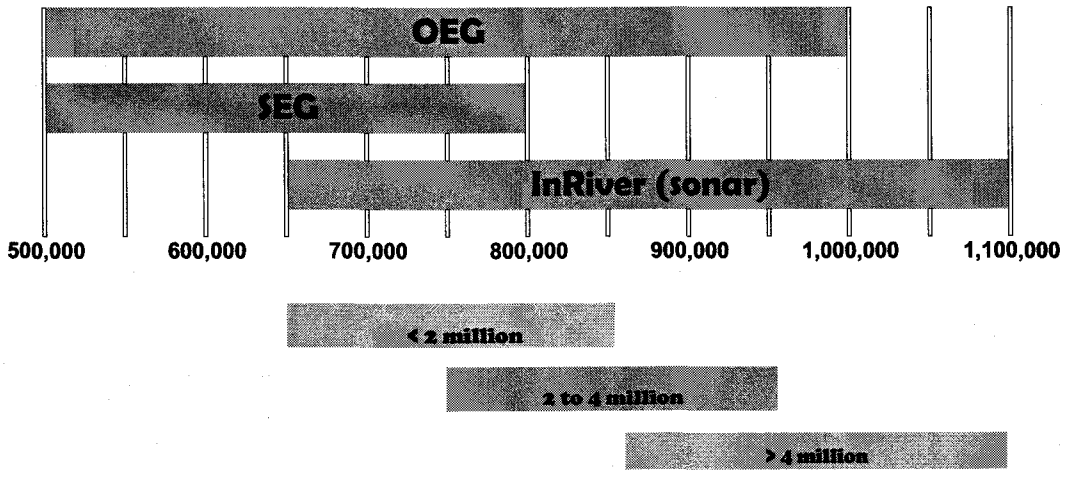
UCI SOCKEYE SALMON ESCAPEMENT OBJECTIVES

System	Goal Range	Goal Type
Kenai River	500,000 - 800,000	SEG
	500,000 - 1,000,000	OEG
	650,000 - 1,100,000[a]	Inriver
Kasilof River	150,000 - 250,000	BEG
	150,000 - 300,000	OEG
Crescent River	25,000 - 50,000	BEG
Yentna River	90,000 - 160,000	SEG
	75,000 - 180,000	OEG
Fish Creek	20,000 - 70,000	SEG
Packers Lake	15,000 - 25,000	BEG

[a]Three-tiered abundance based goal

15

KENAI RIVER SOCKEYE SALMON ESCAPEMENT OBJECTIVES



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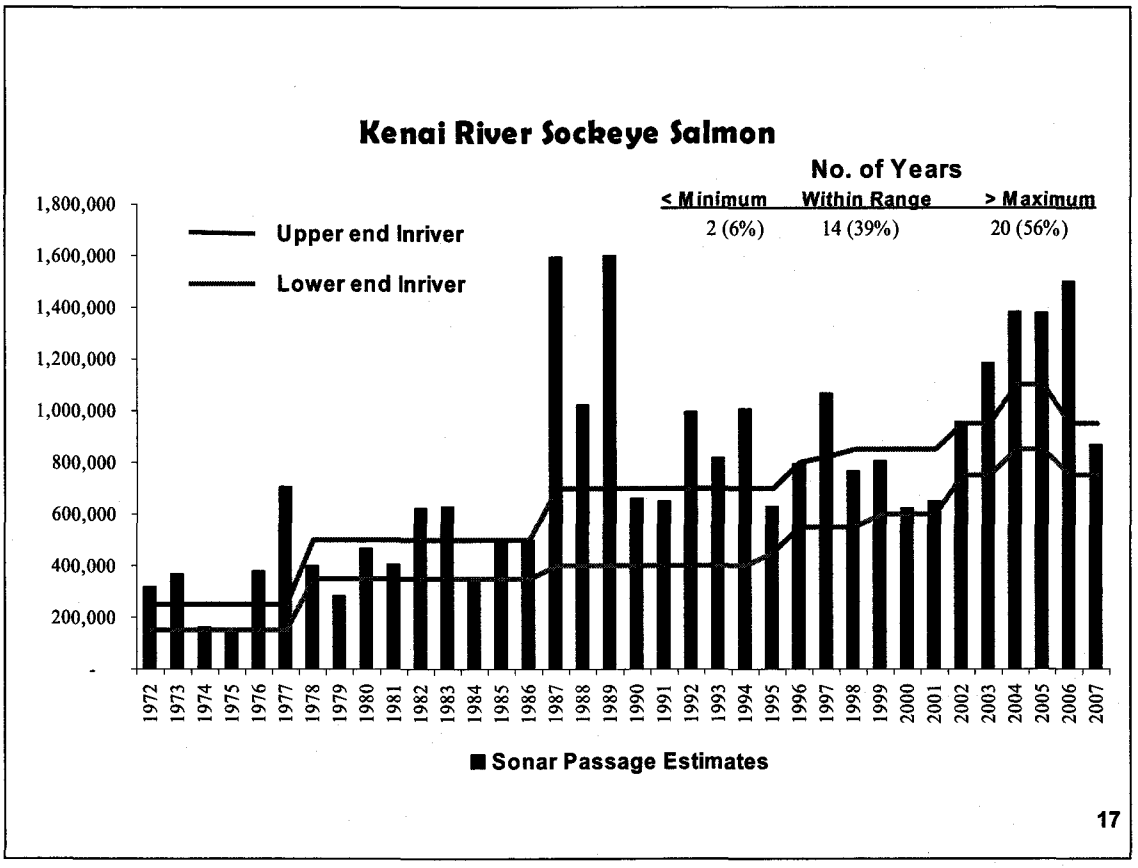
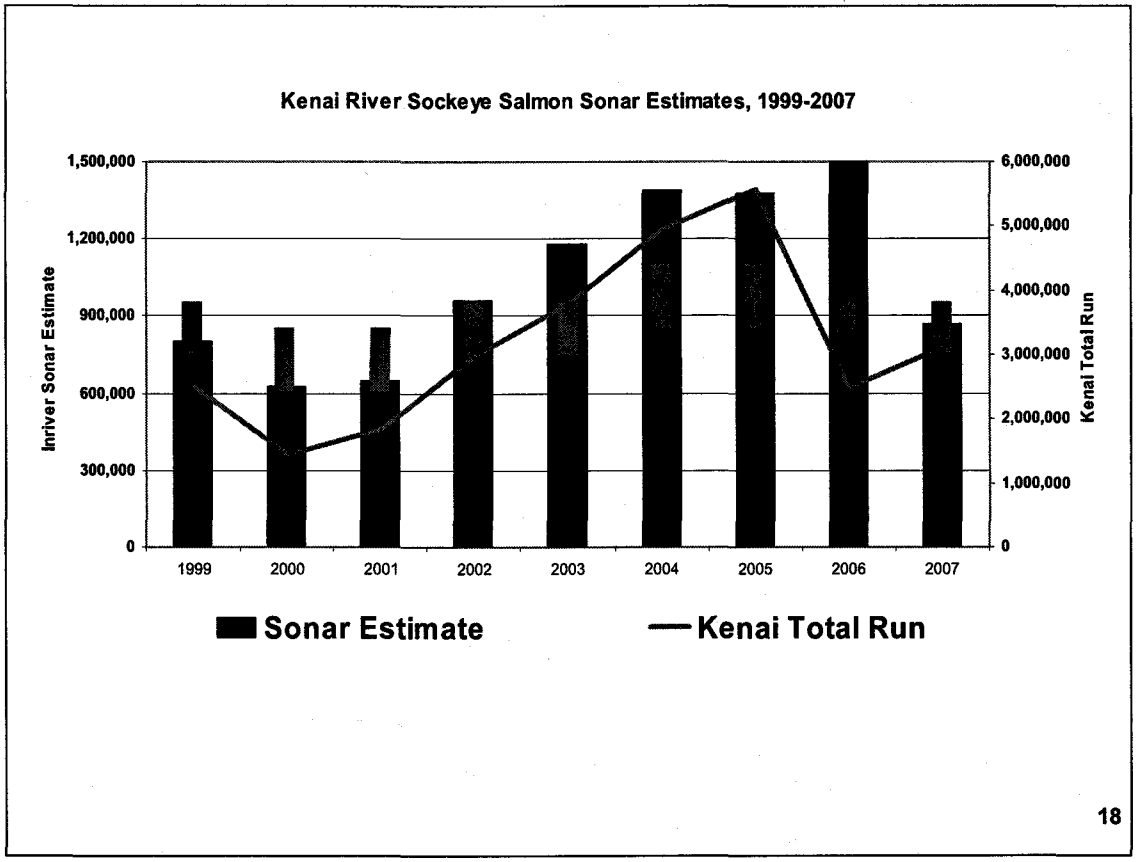
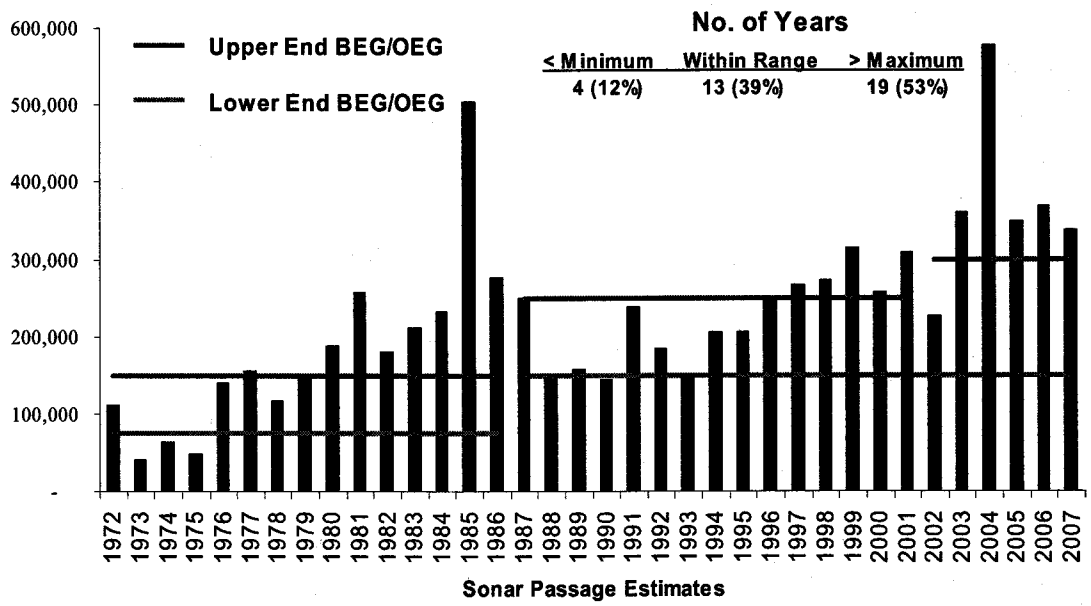

Kenai River Sockeye Salmon
No. of Years
≤ Minimum
Within Range
> Maximum
2 (6%)
14 (39%)
20 (56%)
Upper end Inriver
Lower end Inriver
1,800,000
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
-
1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
Sonar Passage Estimates

17

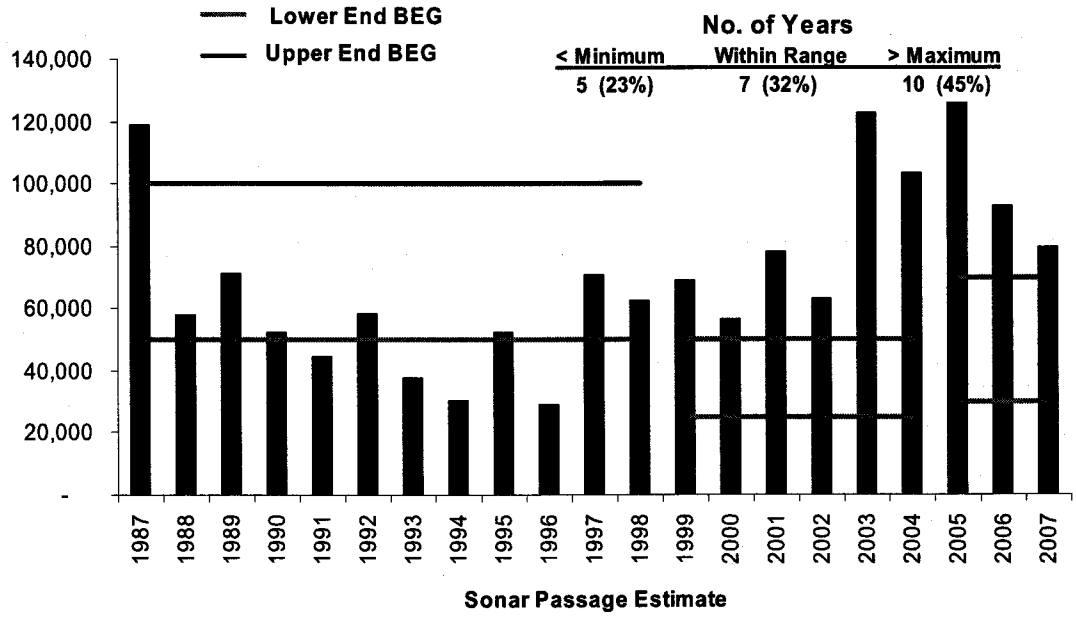

Kenai River Sockeye Salmon Sonar Estimates, 1999-2007
Inriver Sonar Estimate
1,500,000
1,200,000
900,000
600,000
300,000
0
Kenai Total Run
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
0
1999 2000 2001 2002 2003 2004 2005 2006 2007
Sonar Estimate
Kenai Total Run

18

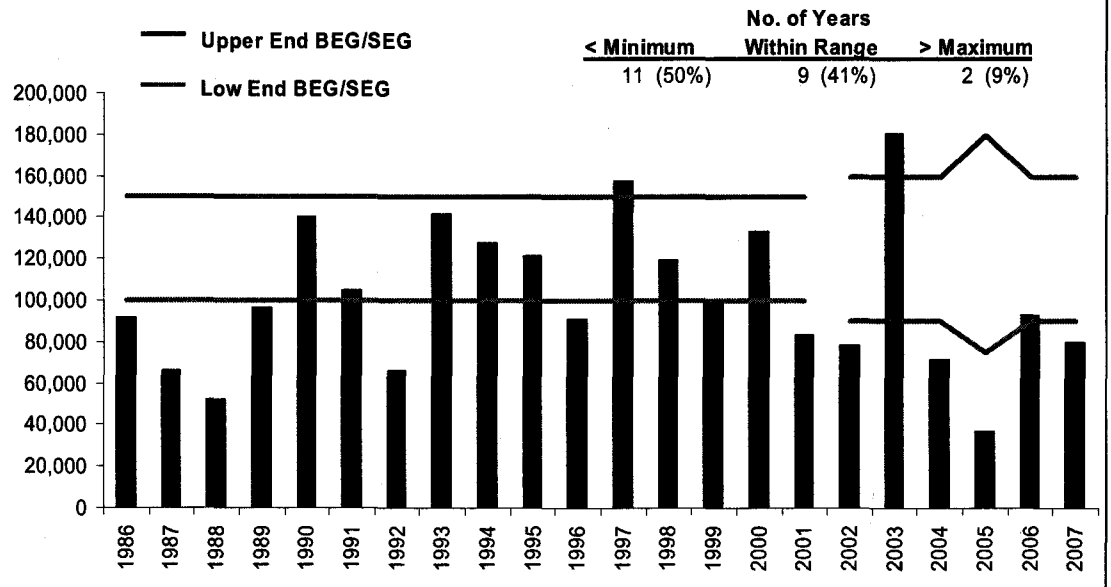
Kasilof River Sockeye Salmon



Crescent River Sockeye Salmon



Yentna River Sockeye Salmon Sonar Passage Estimate



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Northern District Set Gillnet

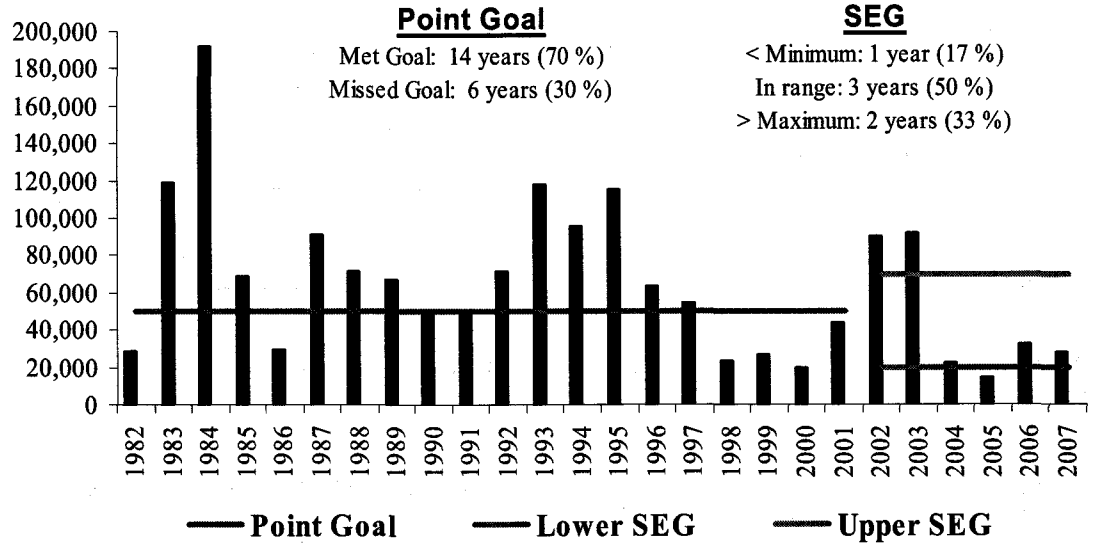
Year	EO	Action	Date
2001	16	Closed ND	23-Jul
	19	Closed ND	26-Jul
2002	14	ND gear reduced to 1 net;	22-Jul
	16	Closed ND	25-Jul
	20	Closed ND	29-Jul
2004	36	Reduce ND to 2 nets	26-Jul
	41	Reduce ND to 1 net	29-Jul
2005	33	Closed ND	20-Jul
	38	Closed ND	25-Jul
	43	Closed ND	28-Jul
	48	Closed ND	1-Aug
	52	Closed ND	4-Aug
2006	9	Closed ND	10-Jul
	12	Closed ND	13-Jul
	16	Closed ND	17-Jul
	20	Closed ND	20-Jul
	27	Closed ND	24-Jul
	28	Closed ND	27-Jul
	31	Closed ND	31-Jul
	35	Closed ND	3-Aug
2007	17	ND reduced to 1 net	23-Jul
	20	Closed ND	26-Jul
	25	Closed ND	30-Jul
	29	Closed ND	2-Aug
	34	Closed ND	6-Aug

22

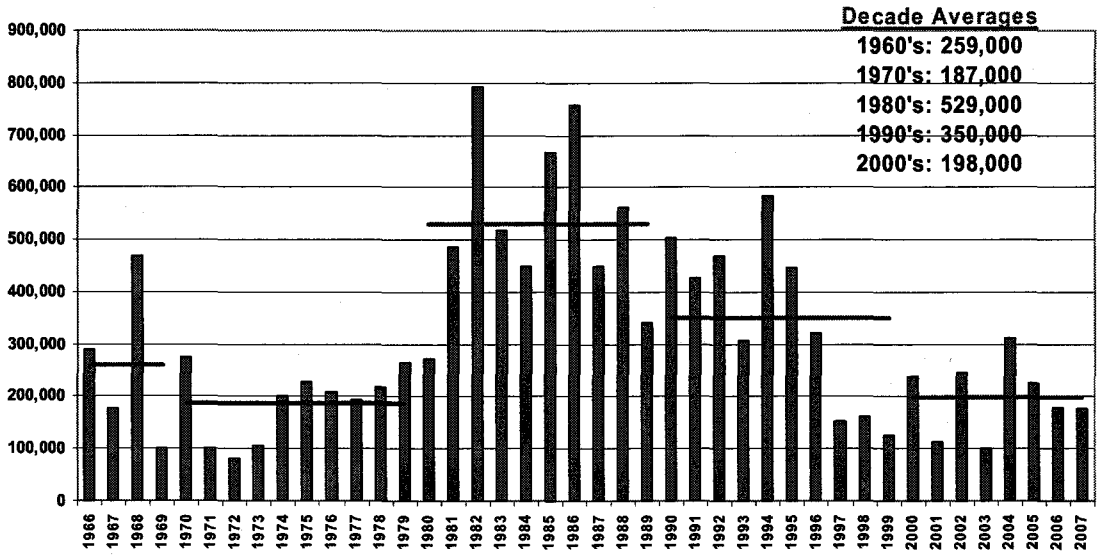
Drift Gillnet

Year	EO	Action	Date
2000	5	Restricted drifting to corridor	10-Jul
	7	Restricted drifting to S. of south end of Kalgin	13-Jul
2001	10	Restricted drifting to corridor	9-Jul
	16	Closed drifting	23-Jul
	19	drifting restricted to corridor	26-Jul
2002	10	Restricted drifting to corridor	11-Jul
	14	Drifting restricted to S. of Colliers	22-Jul
	16	Drifting restricted to S. of south end of Kalgin	25-Jul
	20	Drifting restricted to S. of south end of Kalgin	29-Jul
2003	8	Restricted drifting to corridor	10-Jul
	10	Restricted drifting to S. of Blanchard line	14-Jul
	21	Restricted drifting to conserve ND coho	24-Jul
	24	Restricted drifting to conserve ND coho	28-Jul
2004	15	Restrict drifting to S. of Kalg. Buoy	12-Jul
	18	Restrict drift to S. of N. end of Kalgin Isl	15-Jul
	24	Restrict drift to S. of N. end of Kalgin Isl	21-Jul
	36	Drifting restricted to S. of line from Colliers to Kalgin Isl	26-Jul
	41	Drifting restricted to S. of line from Colliers to Kalgin Isl	29-Jul
2005	na	Restrict to Area 1 on July 11 & 14	7/11 & 7/14
	29	Restrict drifting to Areas 1 & 2	18-Jul
	33	Restrict drifting to S. of Kalgin buoy	20-Jul
	38	Restrict drifting to S. of Blanchard Line	25-Jul
	43	Restrict drifting to S. of line from Colliers to Kalgin Isl	28-Jul
	48	Restrict drifting to S. of line from Colliers to Kalgin Isl	1-Aug
2006	9	Restrict drifting to Ken/Kas Sections	10-Jul
	12	Restrict drifting to Ken/Kas Sections	13-Jul
	16	Restrict drifting to Ken/Kas Sections	17-Jul
	20	Closed drift gillnetting	20-Jul
	27	Closed drift gillnetting	24-Jul
	28	Closed drift gillnetting	27-Jul
	31	Restricted drifting to south of Blanchard Line and Ken/Kas Section	31-Jul
	34	Restricted drifting to south of NW point on Kalgin Isl and Ken/Kas Section	2-Aug
2007	na	Restrict drifting to Area 1	7/9 & 7/12
	9	Restrict drifting to Area 1	16-Jul
	12	Restrict drifting to Area 1	19-Jul
	17	Restrict drifting south of Blanchard	23-Jul
	20	Restrict drifting south of Blanchard	26-Jul
	25	Restrict drifting south of N. Kalgin	30-Jul
	29	Restrict drifting south of Colliers dock to Kalgin	2-Aug
	34	Restrict drifting south of Colliers dock to Kalgin	6-Aug

Fish Creek Sockeye Salmon Escapement

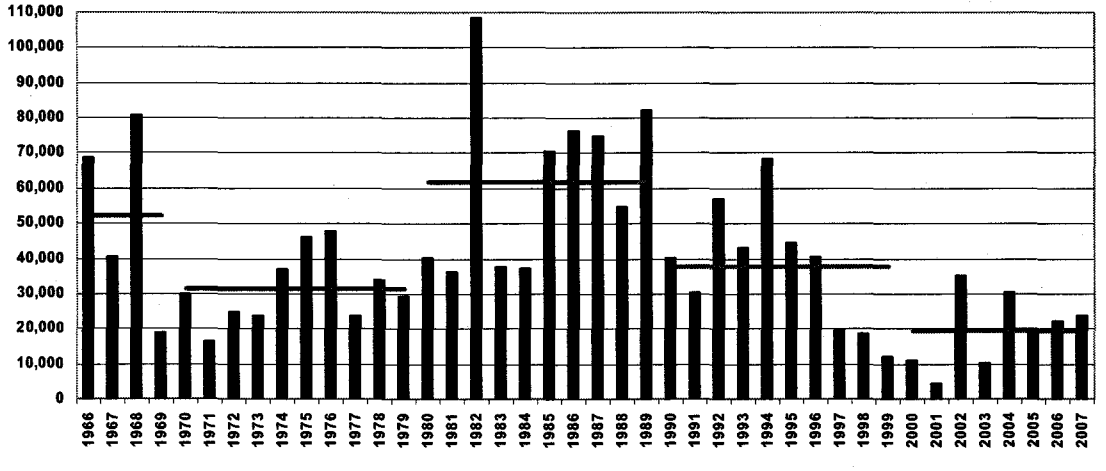


UCI Coho Salmon Commercial Harvest



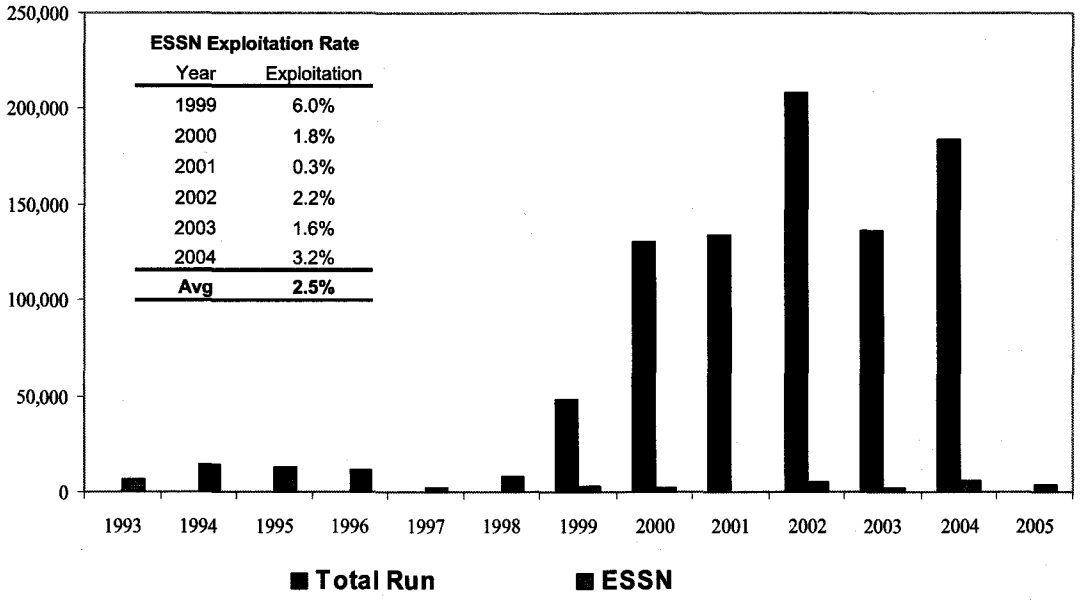
25

ESSN Coho Salmon Harvest



26

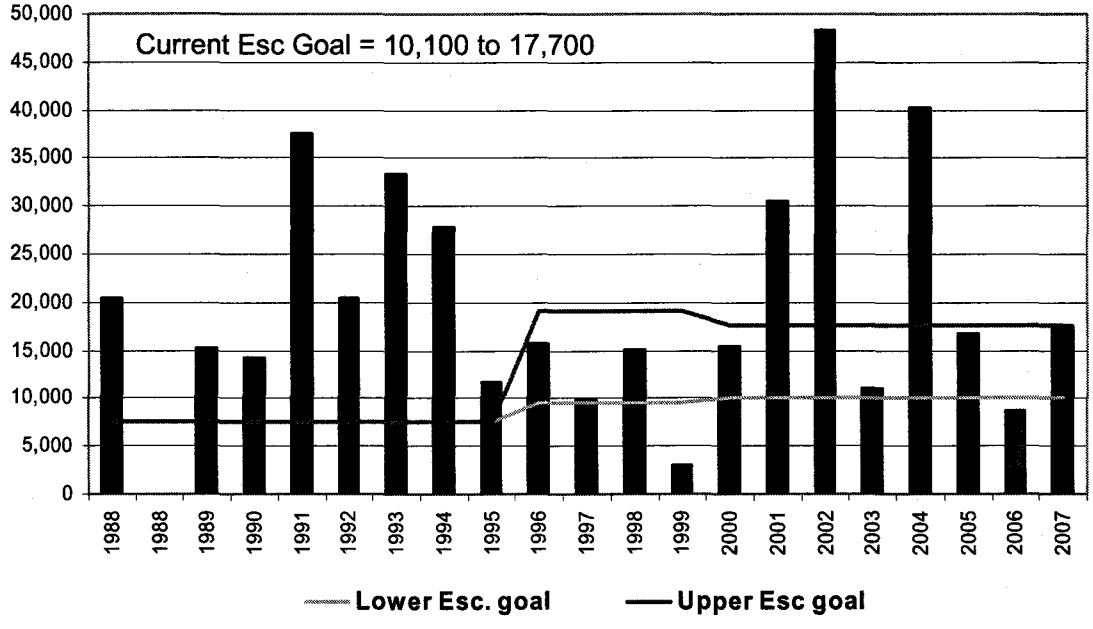
Kenai River Coho Salmon



ESSN Exploitation Rate

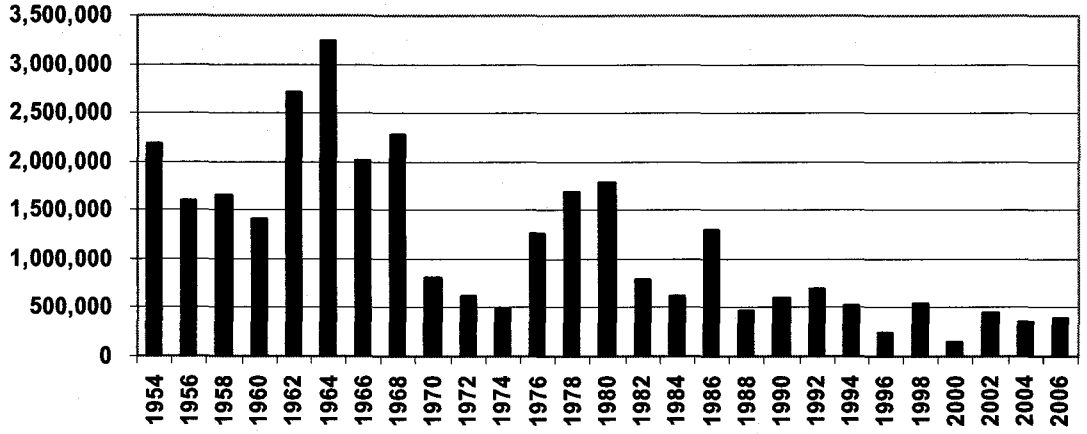
Year	Exploitation
1999	6.0%
2000	1.8%
2001	0.3%
2002	2.2%
2003	1.6%
2004	3.2%
Avg	**2.5%**

Little Susitna River Coho Salmon Weir Counts



From 1988 through 1995 the weir was at river mile 32; since 1996 weir at river mile 71. From 1988 through 1996 escapements include hatchery fish;

UCI Even-Year Pink Salmon Harvest



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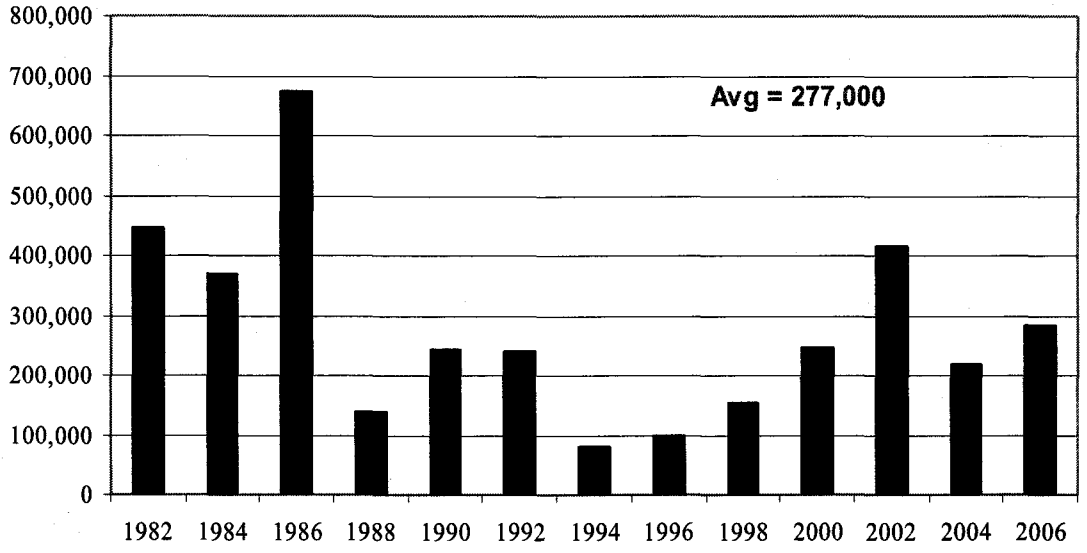
Yentna River Apportioned Even-Yr Pink Salmon Passage



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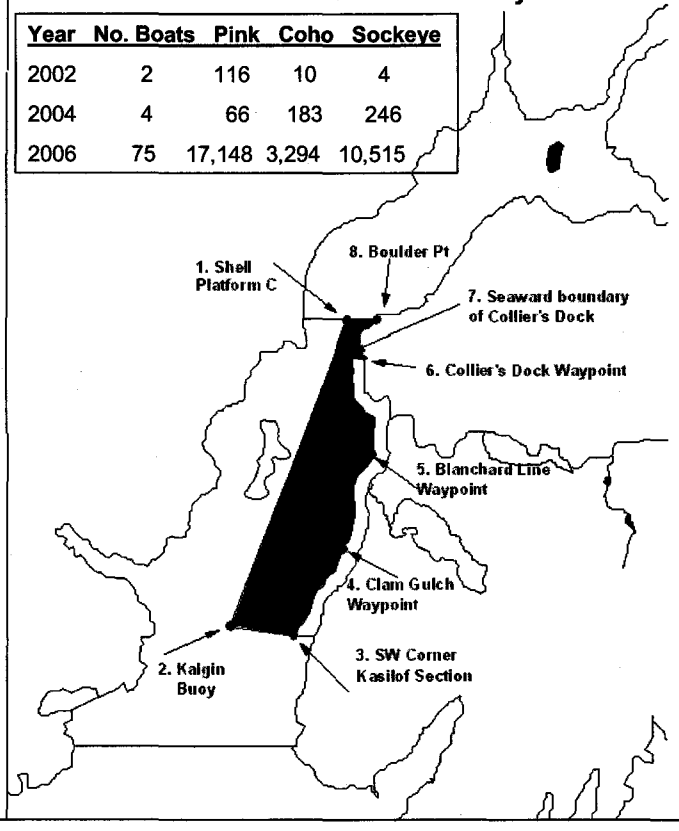
Drift Gillnet Pink Salmon Fishery

Year	No. Boats	Pink	Coho	Sockeye
2002	2	116	10	4
2004	4	66	183	246
2006	75	17,148	3,294	10,515



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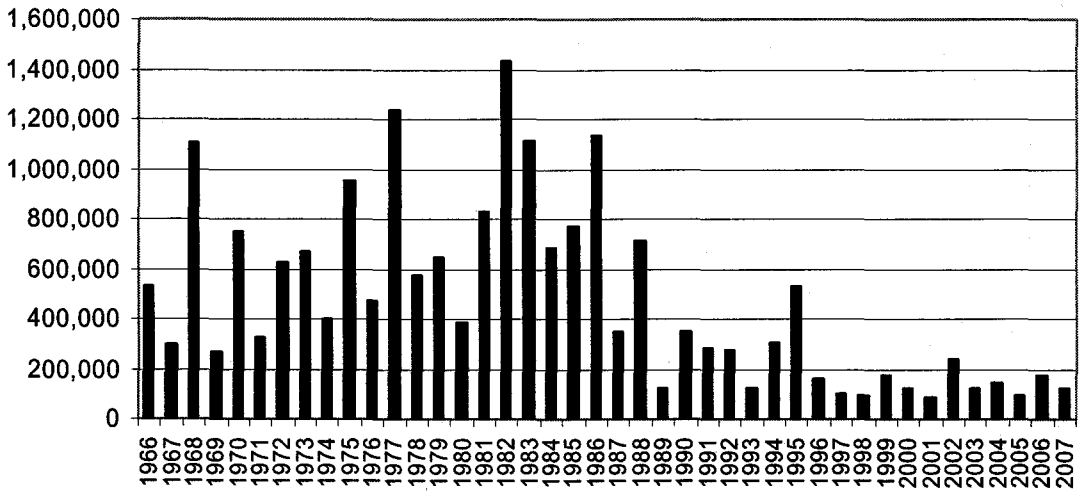
2002 UCI Marine Tagging Study

Population Estimates & Commercial Fishing Exploitation

Species	Tag Type	Estimates (millions) Total Pop.	Harvest	Esc	Exploitation
Coho	Telemetry	1.61	0.25	1.36	15%
	PIT	2.52	0.25	2.27	10%
Pink	**PIT**	**21.28**	**0.45**	**20.83**	**2%**
Chum	PIT	3.88	0.24	3.64	6%

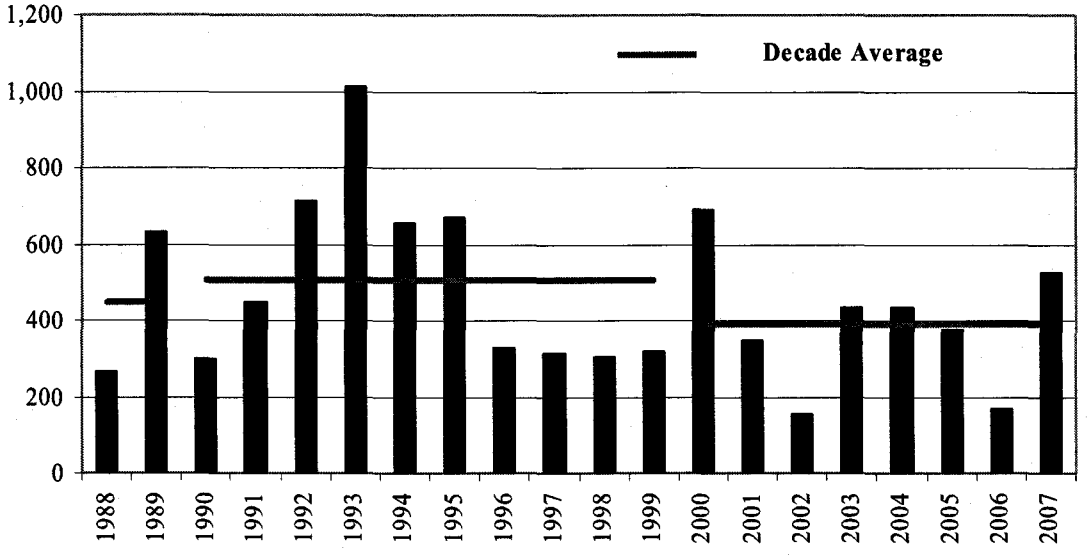
32

Upper Cook Inlet Chum Salmon Commercial Harvest



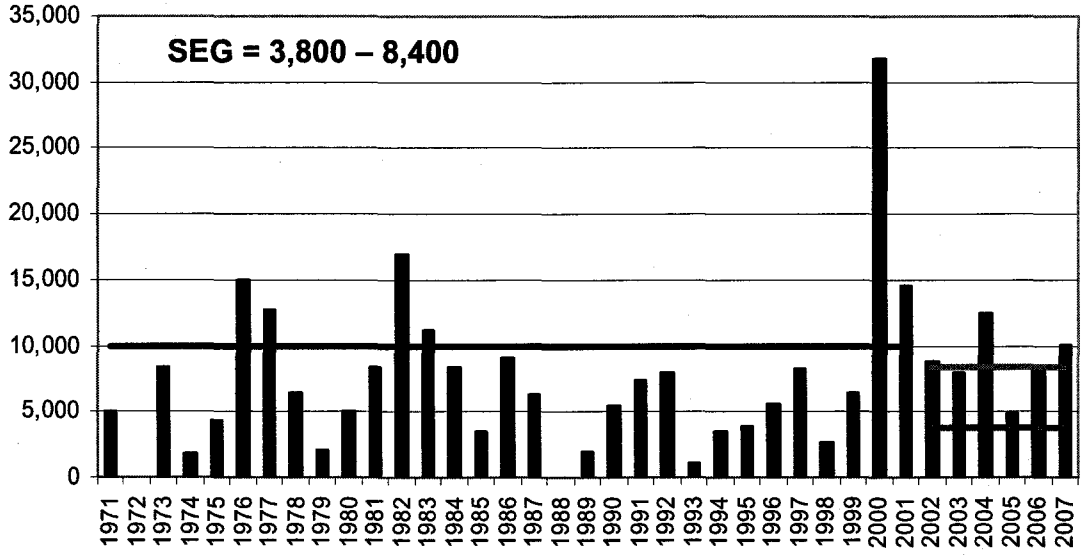
33

OTF Chum Salmon Cumulative CPUE



34

Chinitna Bay Peak Aerial Chum Salmon Surveys



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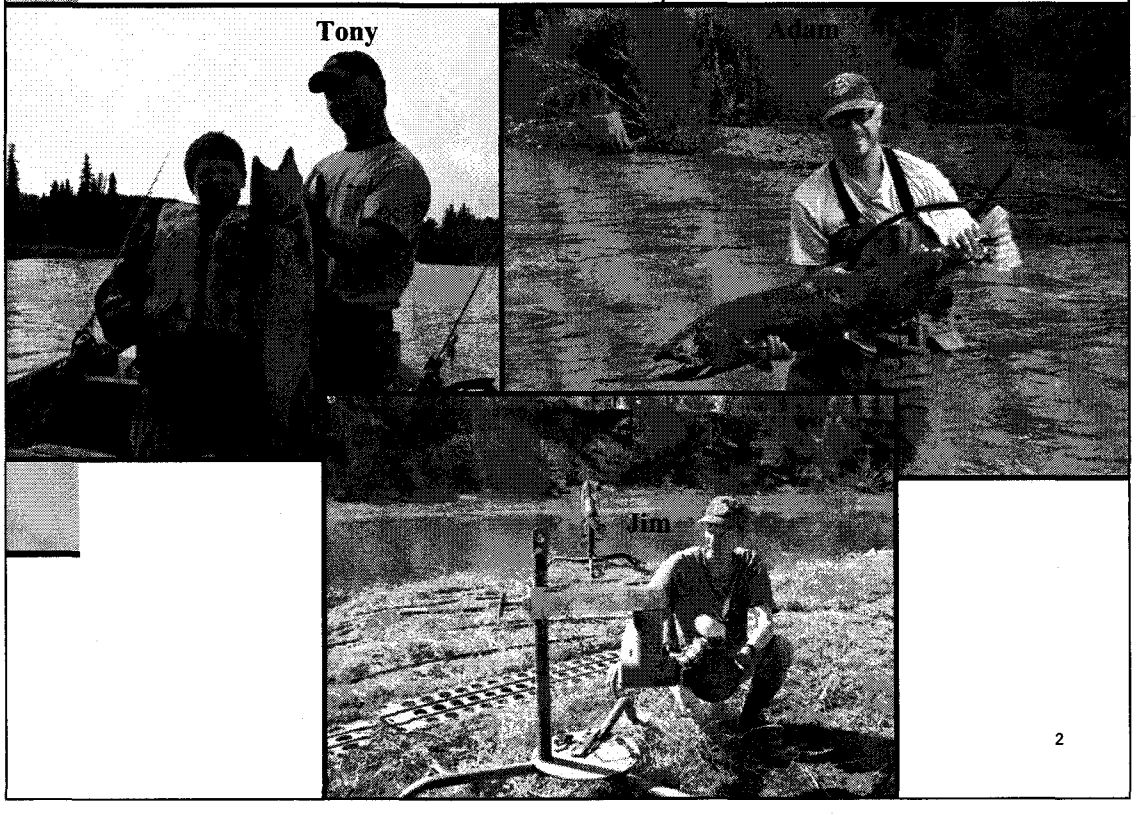
Kenai River Chinook Salmon Assessment and Management

Tim McKinley and Robert Begich

Alaska Department of Fish and Game
Division of Sport Fish
Soldotna

RC 4, Tab 4

Thanks Guys !



What is the goal of our stock assessment ?

☑ 1) have the escapements been achieved ?

☑ 2) composition of the escapements (age-sex-length) ?

☑ 3) how are the early and late runs producing ?

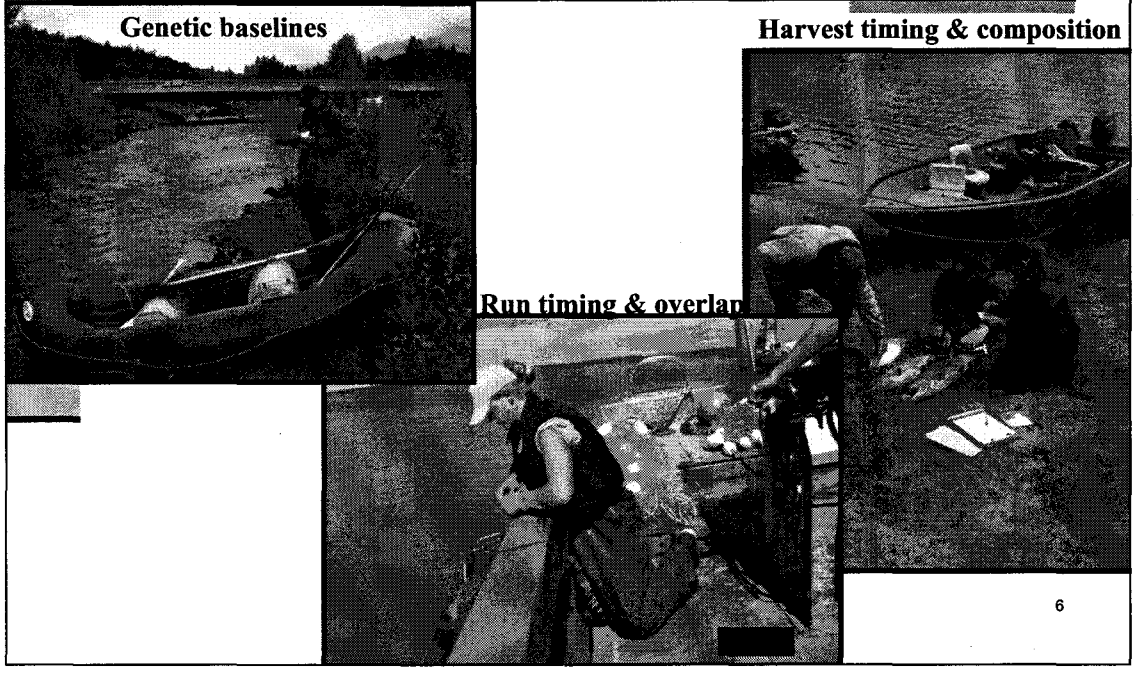
What are the issues before the BOF regarding Kenai River Chinook salmon?

Issue	# of Proposals	Relevant slides
Bait	**2**	**8**
Closed Times/Areas	**5**	**11**
Commercial Fishery	**3**	**7, 18, 20**
Drift/Power boats	12	separate report
Guides/Guided anglers	**31**	**9, 21**
Hatchery fish	**2**	**-**
Non-resident anglers	**4**	**10**
Size regulations	**9**	**12, 13, 14, 22, 23**

In-season Kenai Chinook salmon management: Projected sonar *minus* Projected harvest = Projected escapement

- ✓ **In-season projected sonar estimate for run**
  - *Sonar estimate to date*
  - *Historical run timing comparisons*
- ✓ **In-season projected harvest estimate for run**
  - *Harvest estimate below Soldotna bridge to date*
  - *Historical harvest timing*
  - *Historical harvest upstream of bridge*

Genetic sampling of Kenai River Chinook was begun in 2004 to better understand run timing and harvest timing by stock



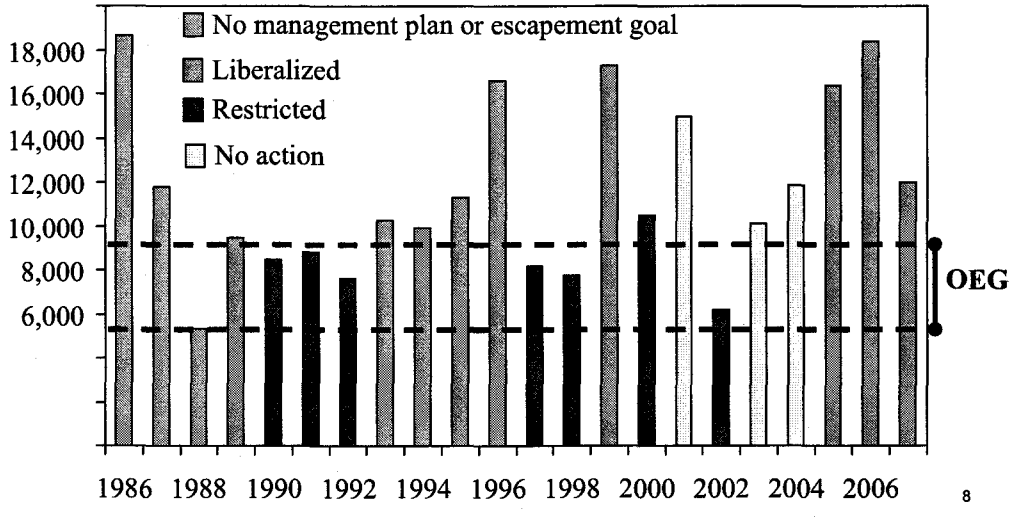
There are 2 runs of Chinook salmon into the Kenai River, each with its own management plan

Early run (late April-June) 5 AAC 57.160

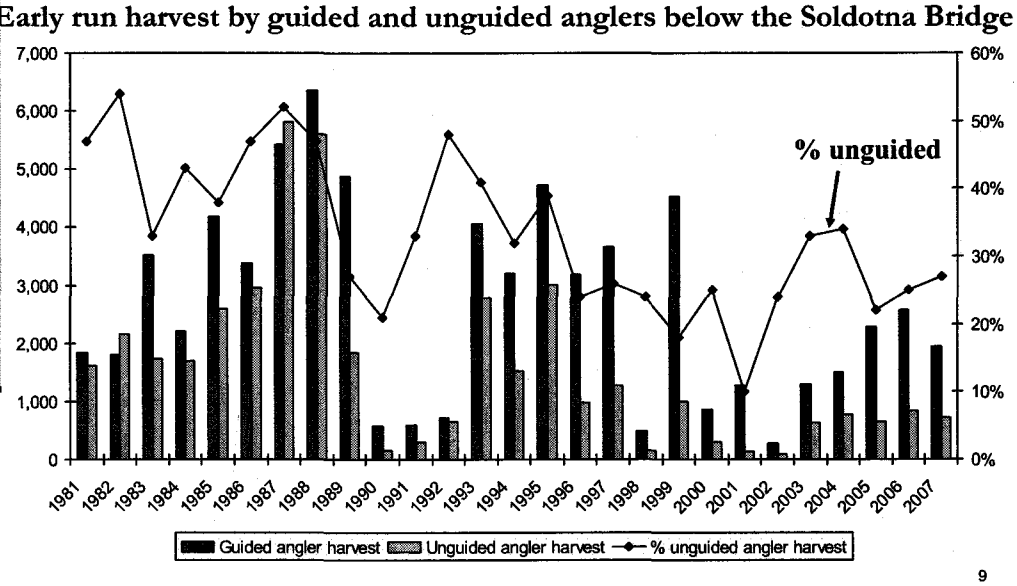
- Likely small but unknown harvest in saltwater sport fishery
- No commercial harvest
- Educational harvest <100
- Inriver run (sonar) averages ~17,000
- Sport fishery recent average ~4,000, almost entirely above sonar
- Inseason creel survey & SWHS to estimate sport harvest
- Escapement = Sonar *minus* Sport harvest *minus* C&R mortality
- Escapement Goal; OEG, set by the BOF (5,300-9,000)
  BEG set by UCI EG Committee (4,000-9,000)
- Spawn primarily in tributaries of the Kenai River

The early run escapement goal set in 1989 was too high and resulted in unnecessary restrictions.

Since 2005 when the OEG of 5,300-9,000 was instituted, there have been zero restrictions and 3 liberalizations.

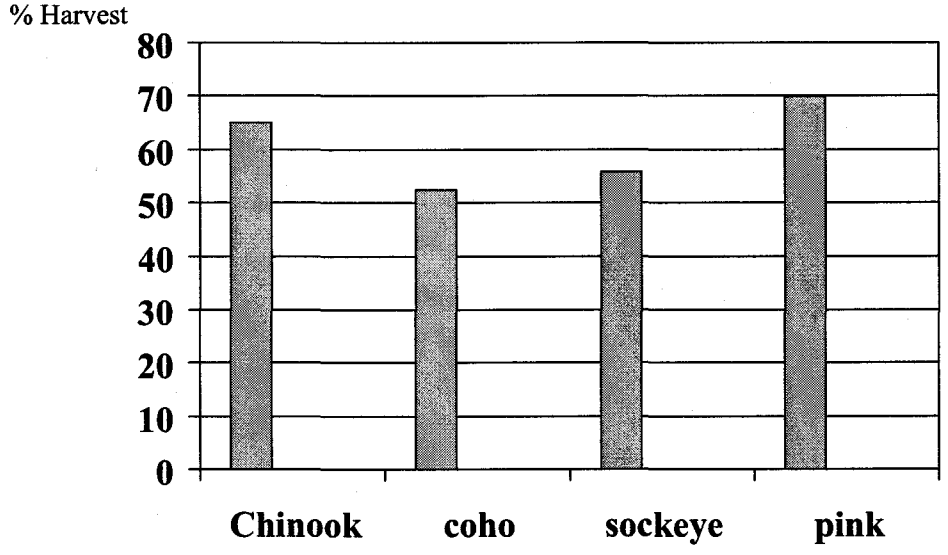


Early run harvest by unguided anglers below the Soldotna Bridge has averaged ~24% since 1999



9

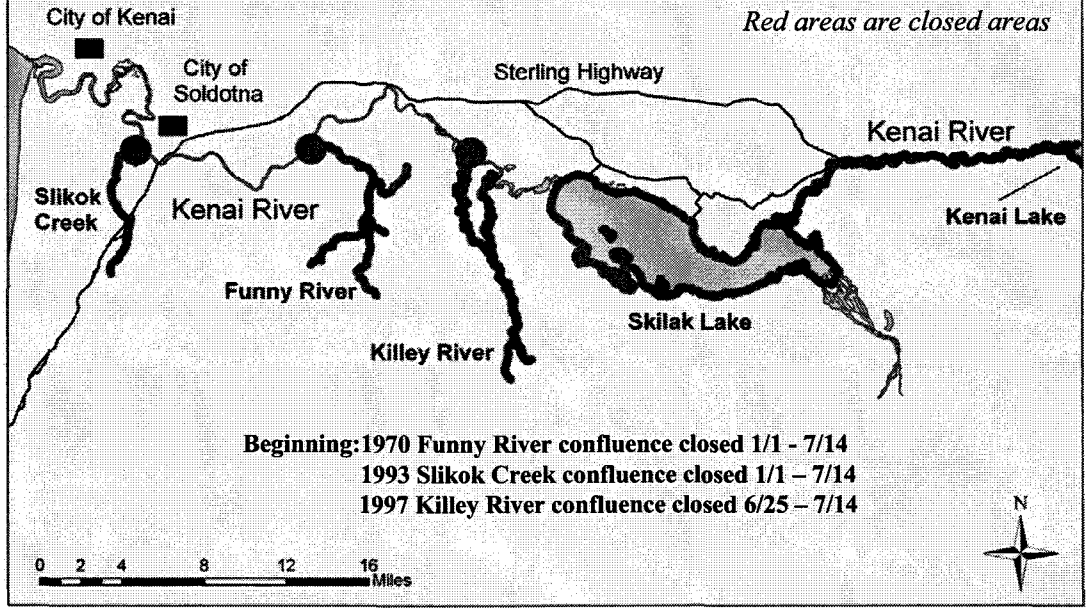
Non-residents account for ~1/2 of the sport harvest in the Kenai River, except for Chinook and pink salmon



Kenai River sport harvest by non-residents, 2001-2006

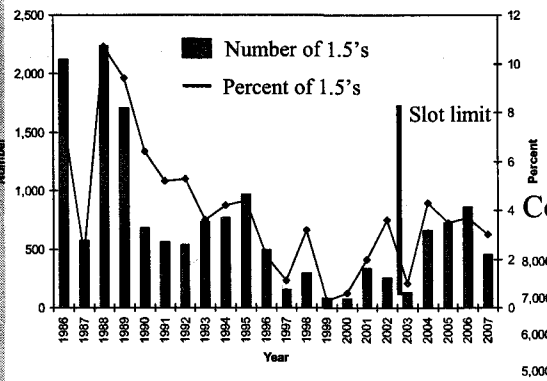
10

To protect staging Chinook salmon:
Tributaries and the entire Upper Kenai are closed year round to Chinook fishing
Tributary confluences are closed seasonally
The entire river is closed after July 31

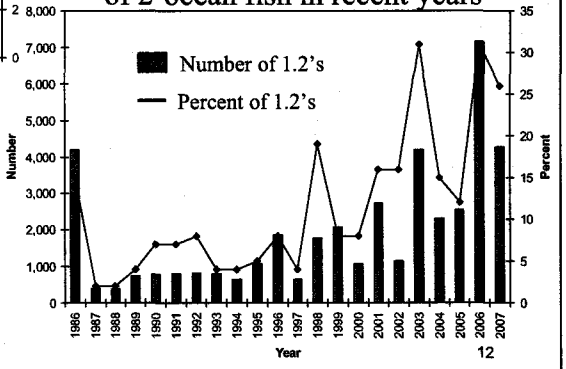


Beginning: 1970 Funny River confluence closed 1/1 - 7/14
1993 Slikok Creek confluence closed 1/1 – 7/14
1997 Killey River confluence closed 6/25 – 7/14

In order to conserve the declining return of 5-ocean fish in the early run, a slot limit whereby Chinook less than 44" or 55" & greater could be retained has been in regulation since 2003

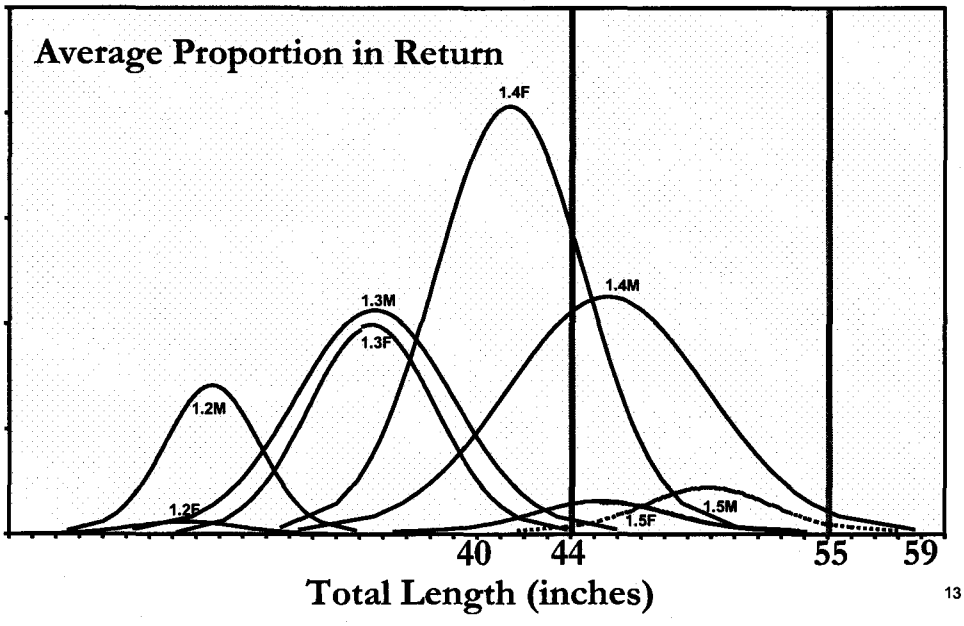


Conversely, there has been a large number of 2-ocean fish in recent years



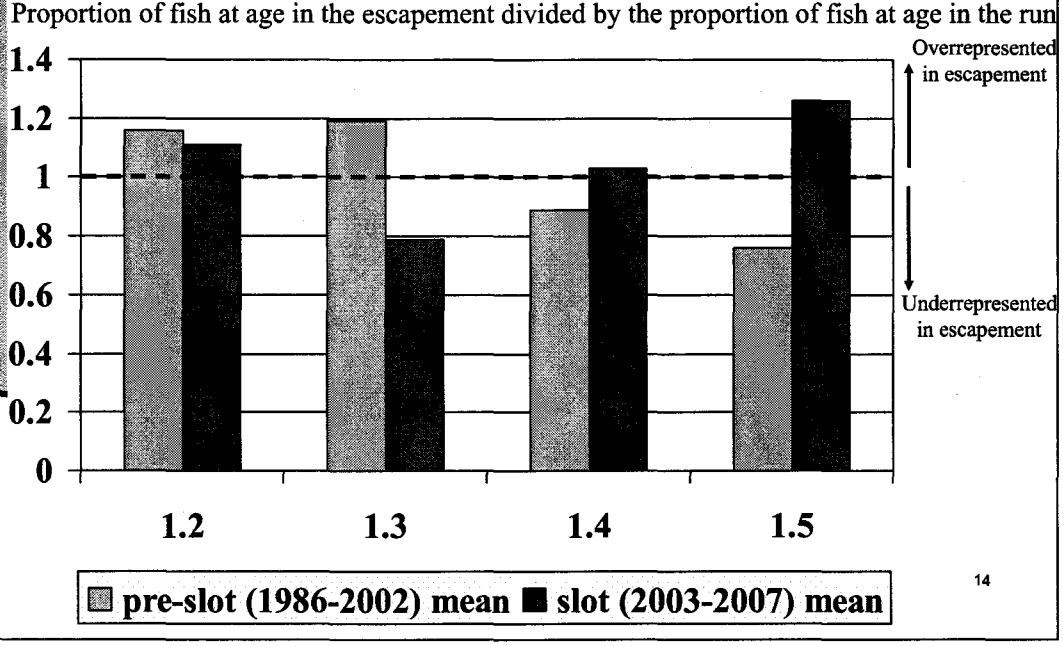
Conundrum:

Finding a length that protected a majority of 5-ocean fish w/out impacting harvest opportunity for other age classes



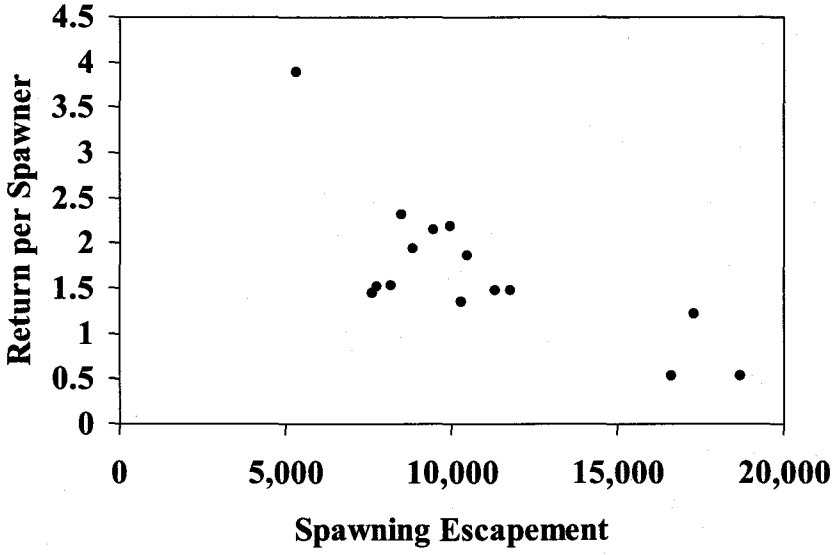
13

The slot limit has not negatively affected the age composition of the escapement, relative to the age composition of the run



14

Return per spawner for early run Kenai River chinook salmon



Early Run Kenai River Chinook salmon summary

① Escapement goal range is always achieved or exceeded

② No in-season restrictions in last 5 seasons

③ Liberalized (bait) every year since new escapement goal (last 3 years)

④ Harvest by unguided anglers is still only ~1/4 of total

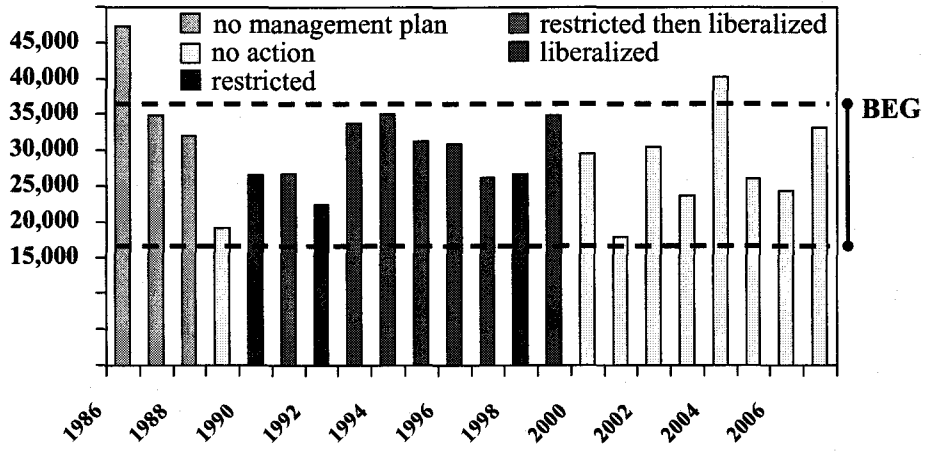
⑤ Slot limit has reduced harvest of 5-ocean fish to zero in 4 of 5 years, without negatively impacting the age or sex composition of the escapement

Much larger run, the Late run

Late run (late June-August) 5 AAC 21.359

- Harvest in saltwater sport fishery averages ~1,000 in recent years
- Commercial harvest ranges from 5,000–23,000 & averages ~13,000 in recent years, with most (~93%) in the ESSN fishery
- Personal Use dip net harvest ranges from 800-1,500 in recent years
- Inriver run (sonar) ranges from 30,000-60,000 & averages ~43,000 in recent years
- Inriver sport harvest ranges from 8,000-19,000 & averages ~15,000 in recent years
- Inseason creel survey & SWHS used to estimate sport harvest
- Escapement = Sonar *minus* Sport harvest above Sonar *minus* C&R mort.
- Escapement Goal (BEG) 17,800-35,700 (no change since 1999)
- Spawn primarily in the Kenai River mainstem

There have been no restrictions and only 1 liberalization since the current BEG (17,800-35,700) went into effect in 1999 for Kenai River late run Chinook salmon



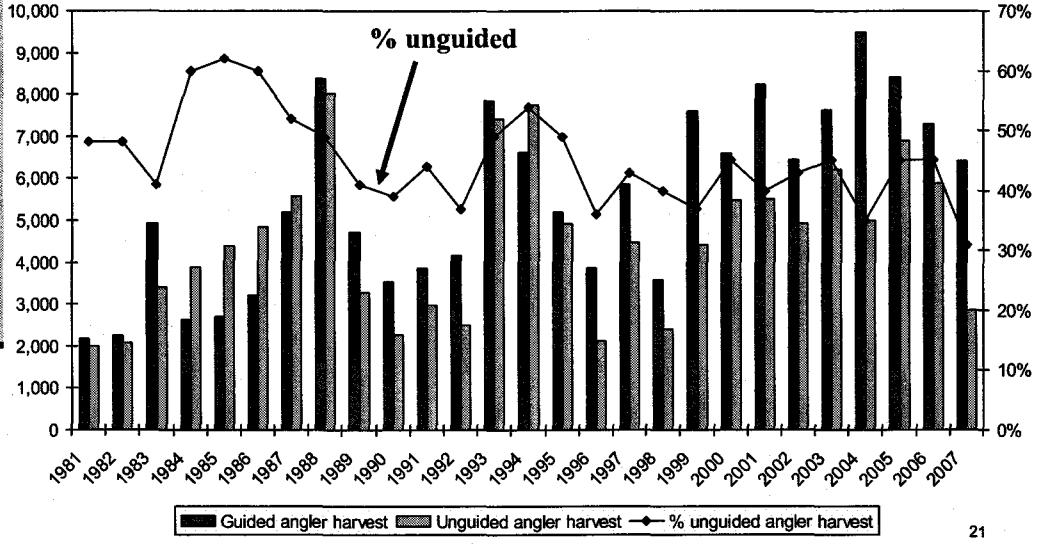
Late run Kenai River Chinook salmon escapements

In-season management guidelines relevant to late run king salmon harvests (5 AAC 21.359)

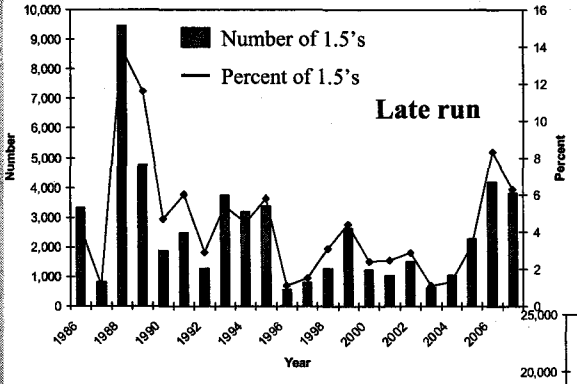
Time Frame	*Projected* Kenai king salmon sonar	*Projected* Kenai king salmon escapement	Kenai River In-river sport	East side set net	Deep Creek marine	Upper Cook Inlet drift
Entire king salmon run	—	*If* >35.7K	*May* extend ≤7 days during the 1st week in August (b1A)			
	If <17.8K	—	*Shall* CLOSE (b3A)	*Shall* CLOSE (b3C)	*Shall* CLOSE (b3A)	*Shall* CLOSE *(near shore)* (b3B)
7/20-31	*If* <40K	*And* <17.8K	*May* RESTRICT (c2)			
7/20-31	*If* <40K	*And* <17.8K	*And* CLOSED (c2)	CLOSED (c4)		
Entire king salmon run	*If* <40K	—		*May not* reduce closed waters at KR mouth (e)		*May not* reduce closed waters at KR mouth (e)

Late run harvest by unguided anglers below the Soldotna Bridge has averaged ~ 41% since 1999

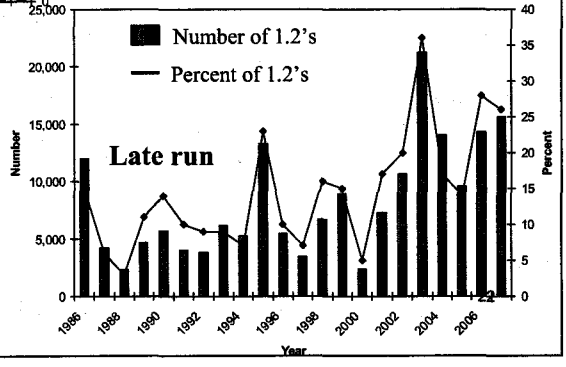
Late run harvest by guided and unguided anglers below the Soldotna Bridge



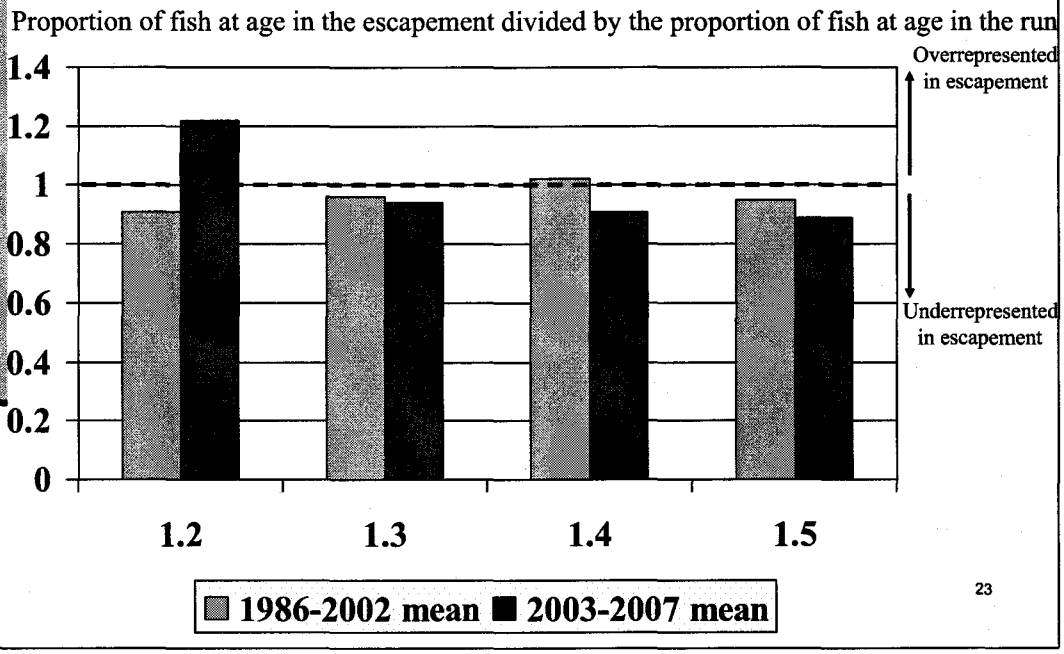
Unlike the early run, the number of 5-ocean Chinook salmon in the late run are not a cause for concern



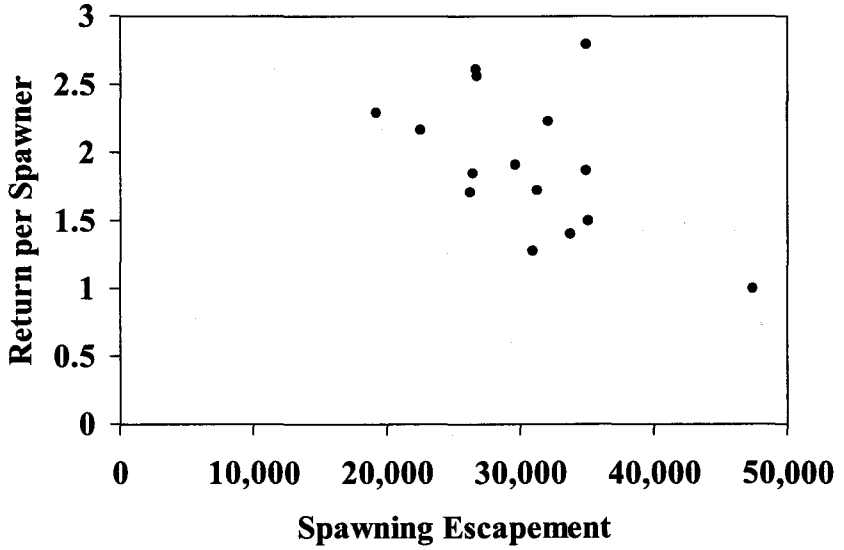
Similar to the early run, there has been a large number of 2-ocean fish in recent years



The age composition of the escapement closely matches the age composition of the run



Return per spawner for late run Kenai River Chinook salmon



Late Run Kenai River Chinook salmon summary

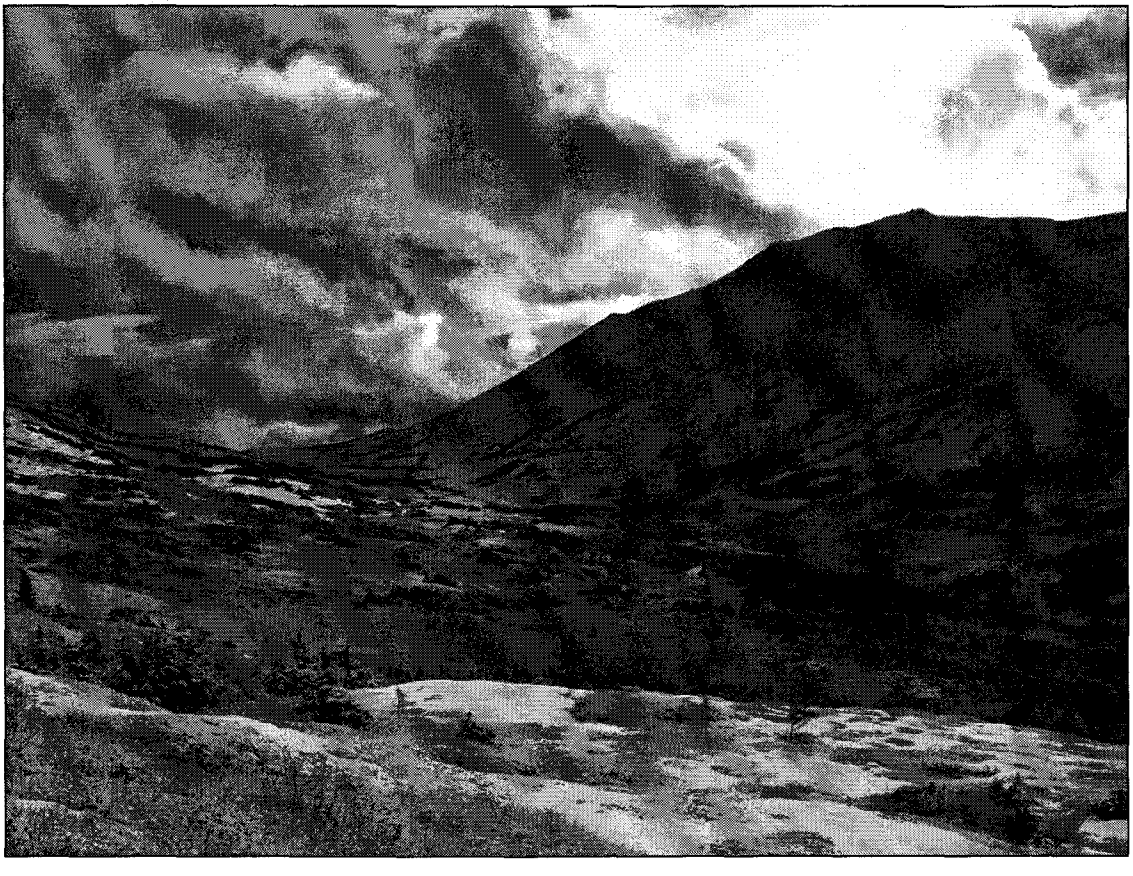
① The low end of the escapement goal is always achieved and occasionally the upper end is exceeded

② No in-season restrictions since 1998

③ Harvest by unguided anglers averages a little under ½ of total, but was as low as ~30% in 2007

④ The number of 5-ocean fish is not a concern

⑤ The age composition of the escapement closely matches the age composition of the run



Cook Inlet Personal Use Salmon Fisheries

Robert Begich & Kristine Dunker

Alaska Department of Fish and Game

Sport Fish Division

RC 4 Tab 5

TALK OUTLINE

- Proposals 211 – 224, 356-358
- Personal Use Fisheries
  - History
  - Management Plan
  - Monitoring Program
- Characteristics
  - Location
  - Seasons
  - Harvests
  - Participation

History

Cook Inlet Subsistence Fisheries

State of Alaska

Board of Fisheries

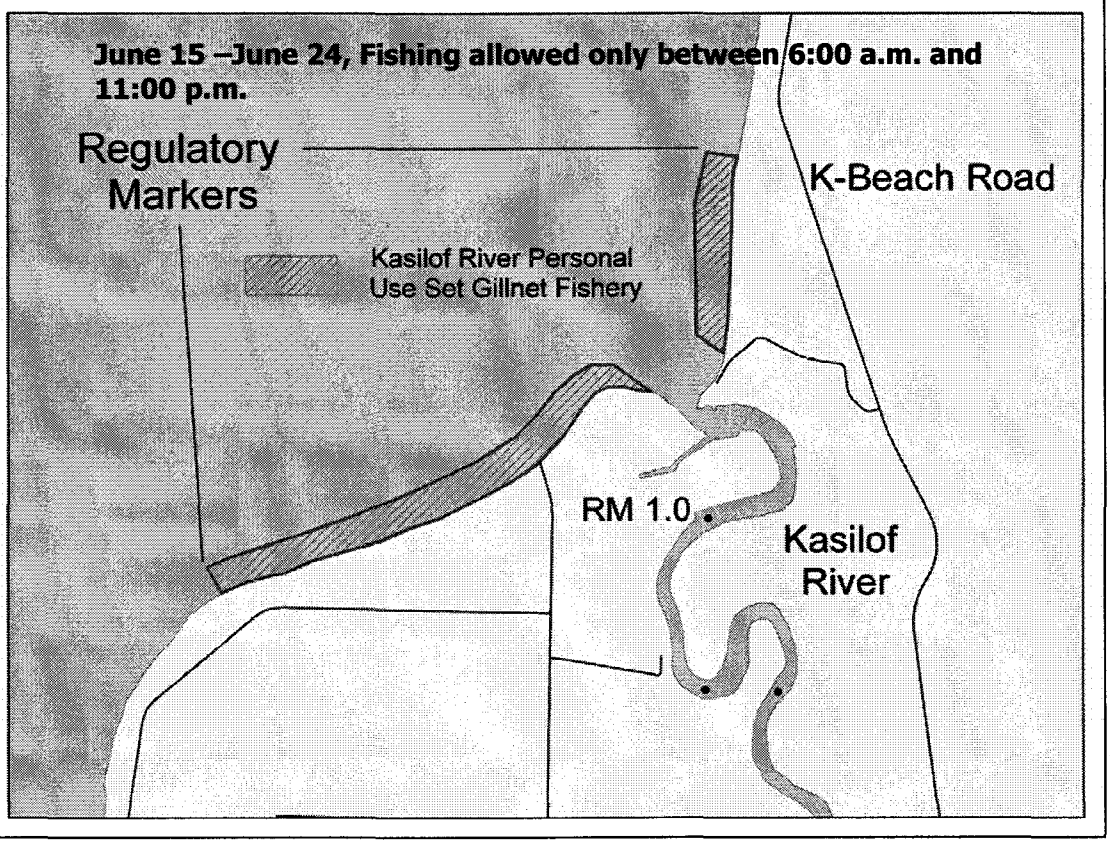
Cook Inlet Personal Use Fisheries

UCI Personal Use Salmon Fishery Management Plan 1996

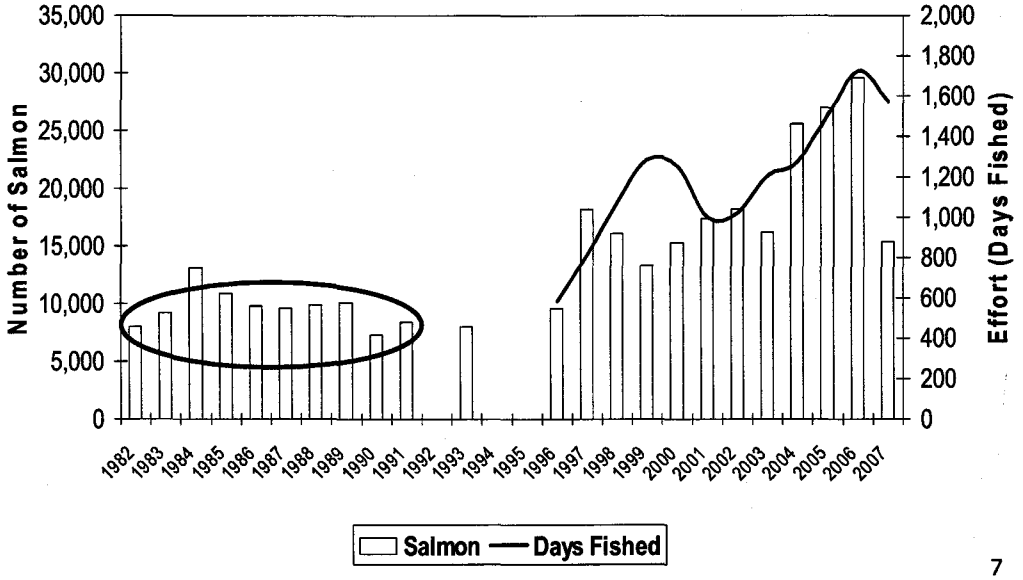
- 5 AAC 77.540: Locations, season dates, methods, Kasilof River set gillnet and dipnet, Kenai River and Fish Creek dip net.
- Annual limit for each personal use fishing permit as 25 salmon for the head of a household and 10 additional salmon for each dependent.
- Marking requirements.
- Permit reporting requirements.
- Part of other salmon management plans

Monitoring Program

- Permit cards returned to estimate annual harvest by species and days fished by location
- 30,000 permits printed/ 63 vendors
- Permits returned by August 15th
- 1st Reminder sent September 15th
- 2nd Reminder sent October 15th
- 82%-89% response rate

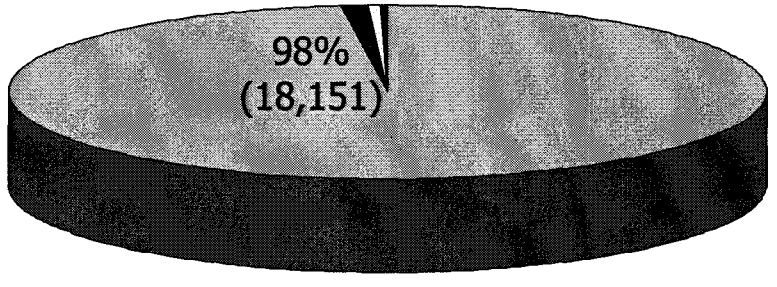


Kasilof River Set Gillnet Harvest & Participation

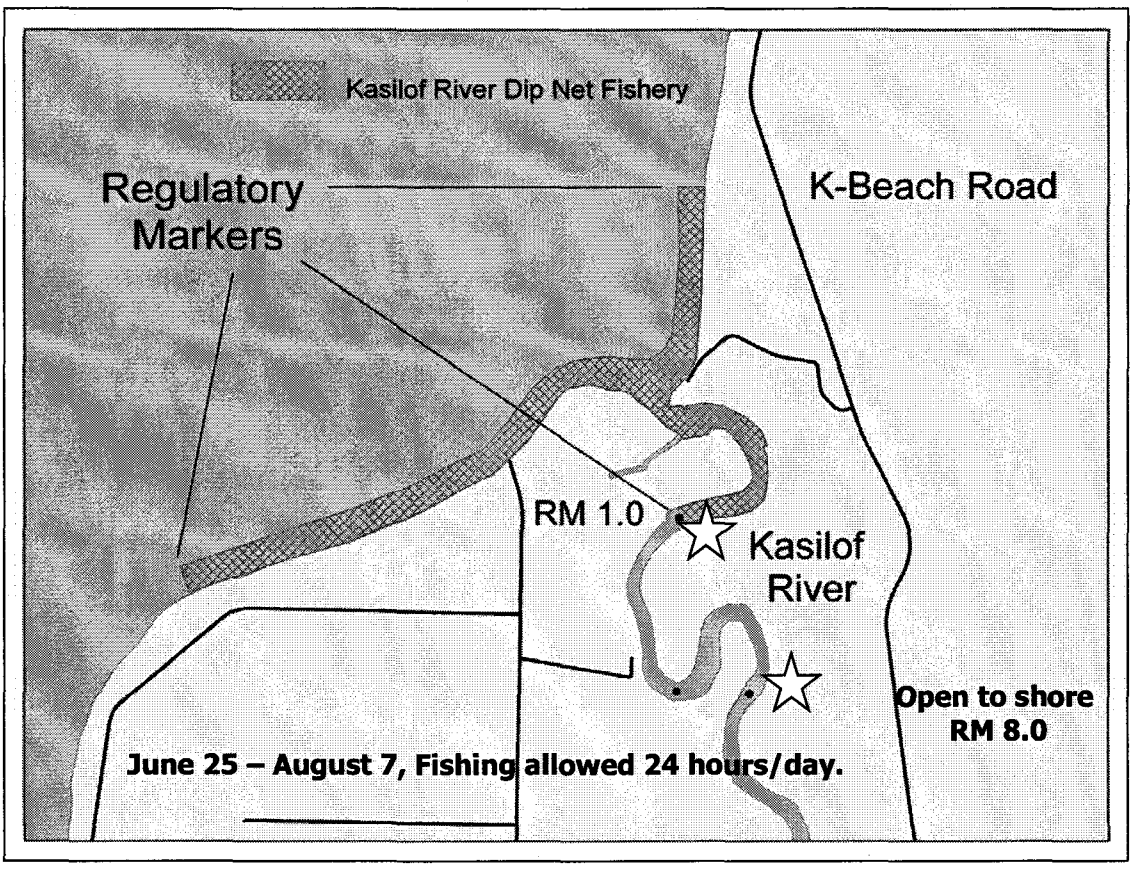


Kasilof River Set Gillnet

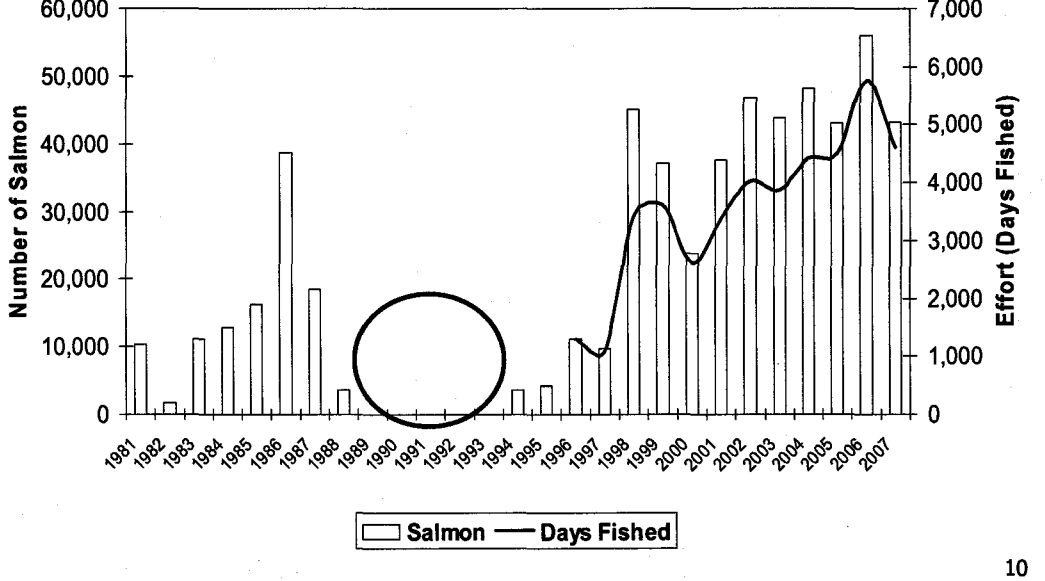
Average Harvest Composition 1996-2007



Sockeye **King** **Coho** **Other**

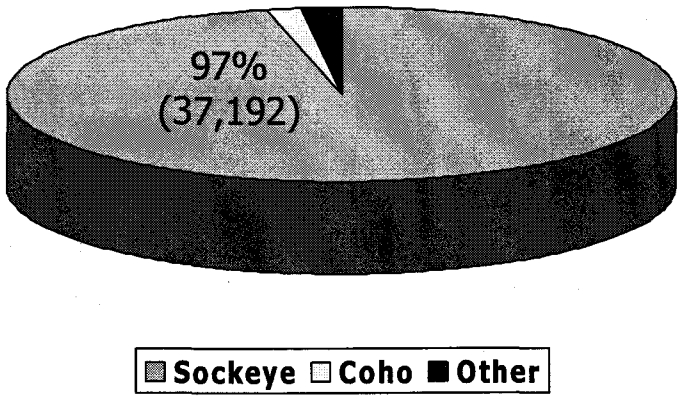


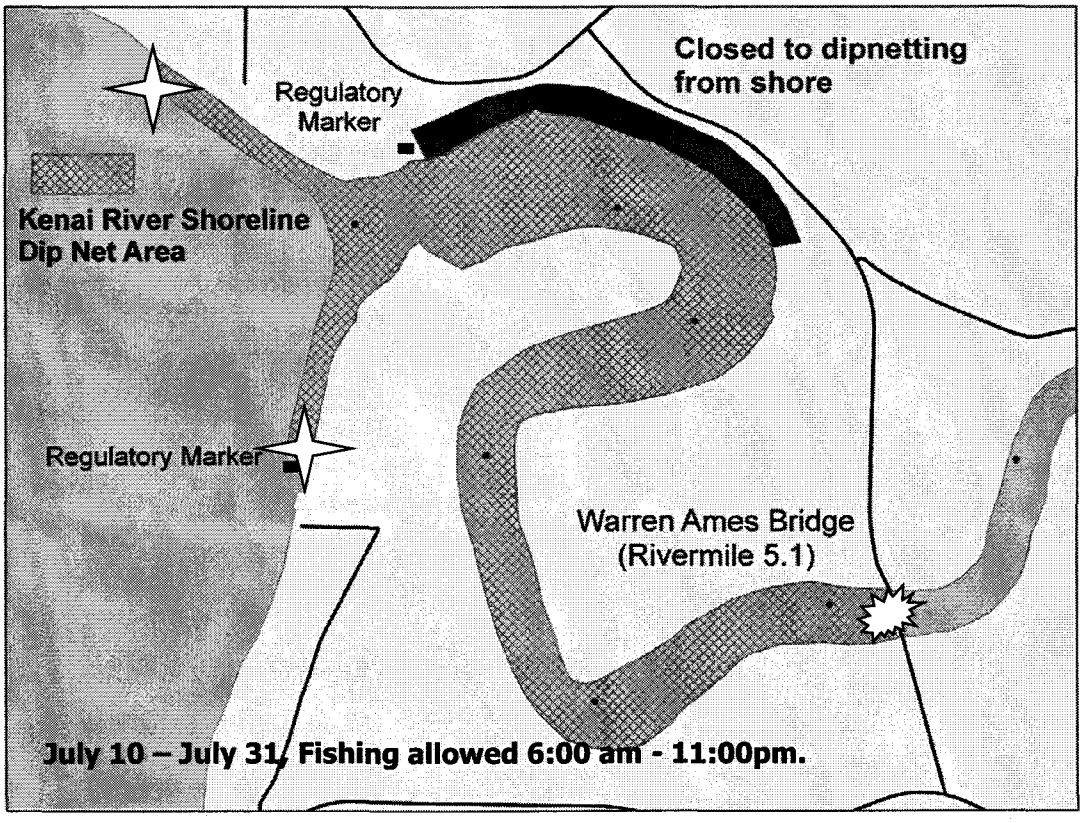
Kasilof River Dip Net Harvest & Participation

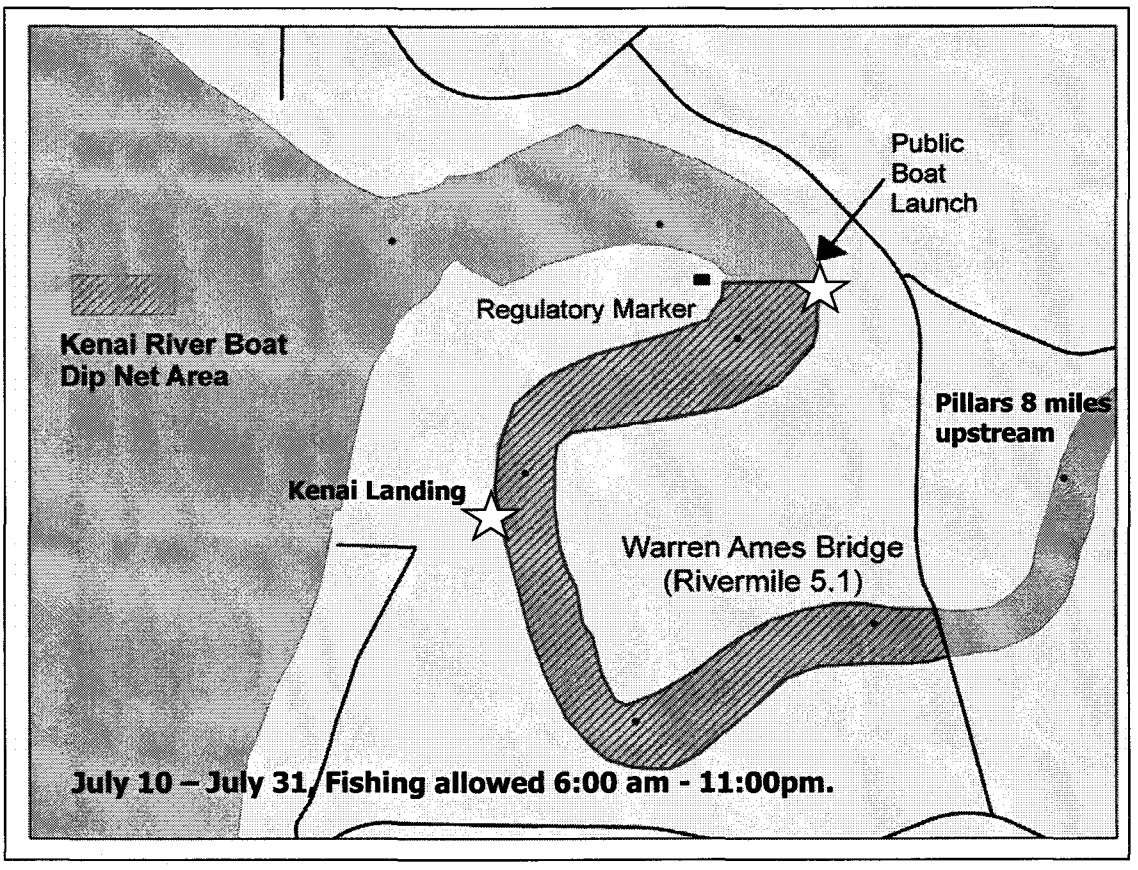


Kasilof River Dip Net

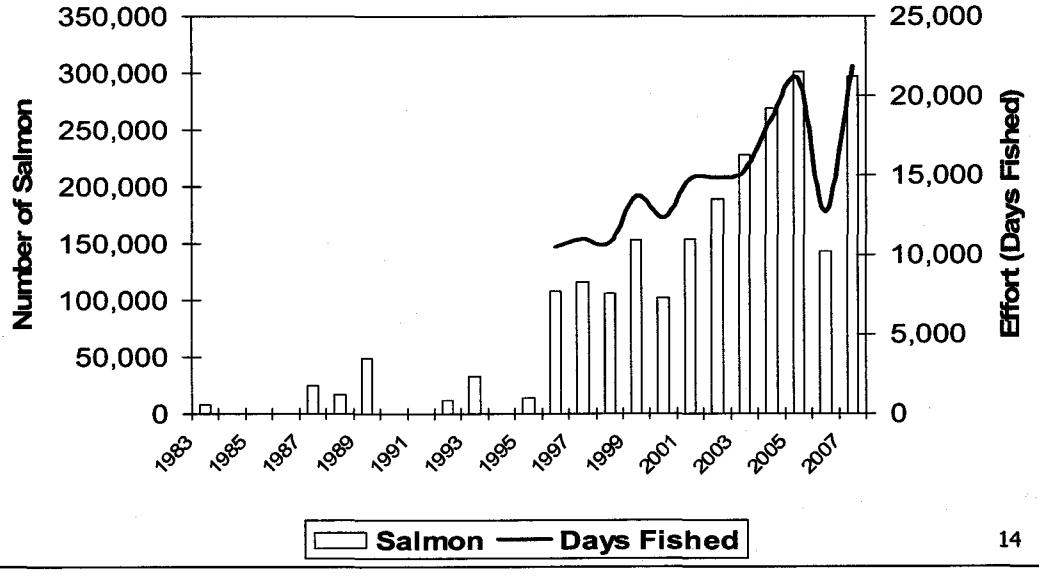
Average Harvest Composition 1996-2007





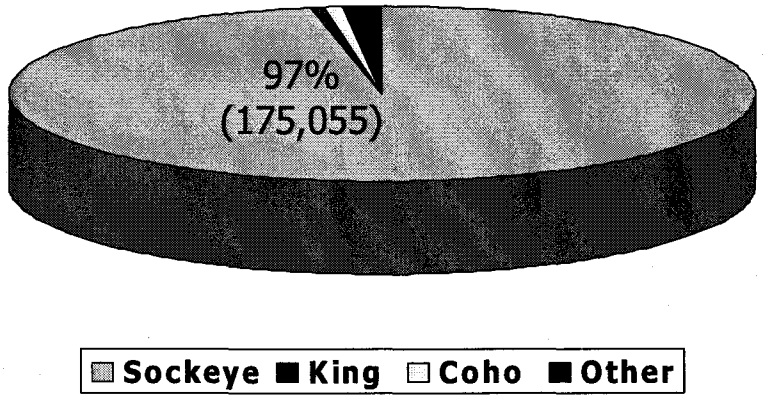


Kenai River Dip Net Harvest & Participation

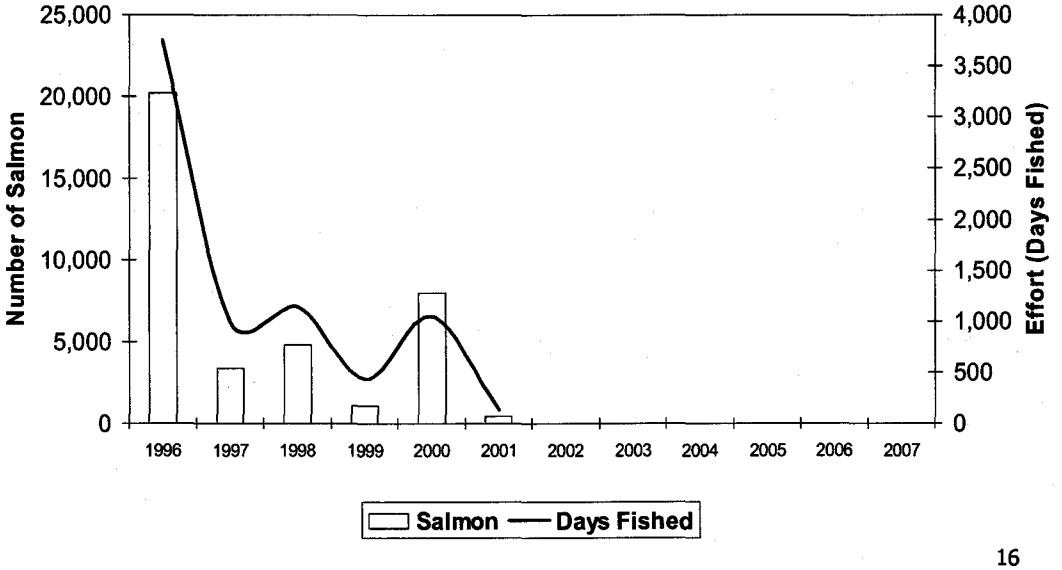


Kenai River Dip Net

Average Harvest Composition 1996-2007

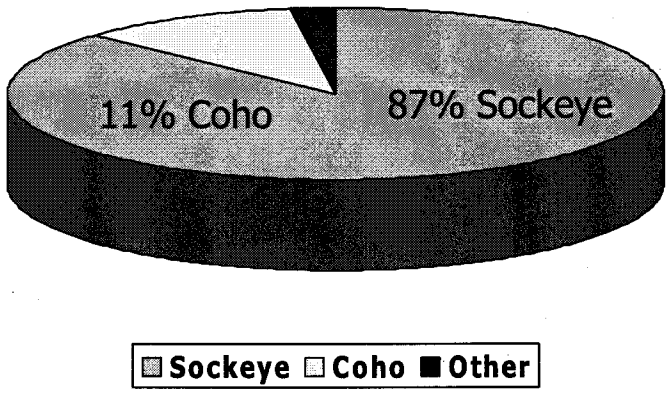


Fish Creek Dip Net Harvest & Participation

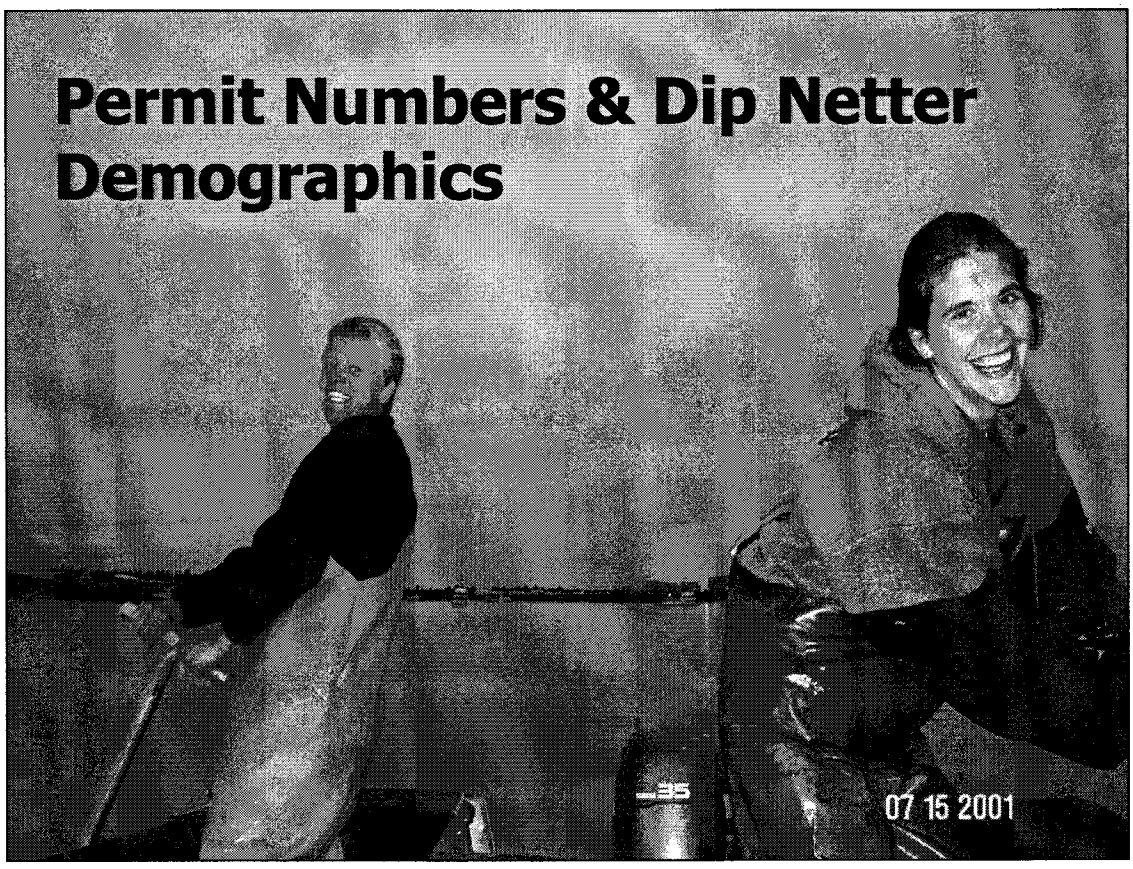


Fish Creek Dip Net

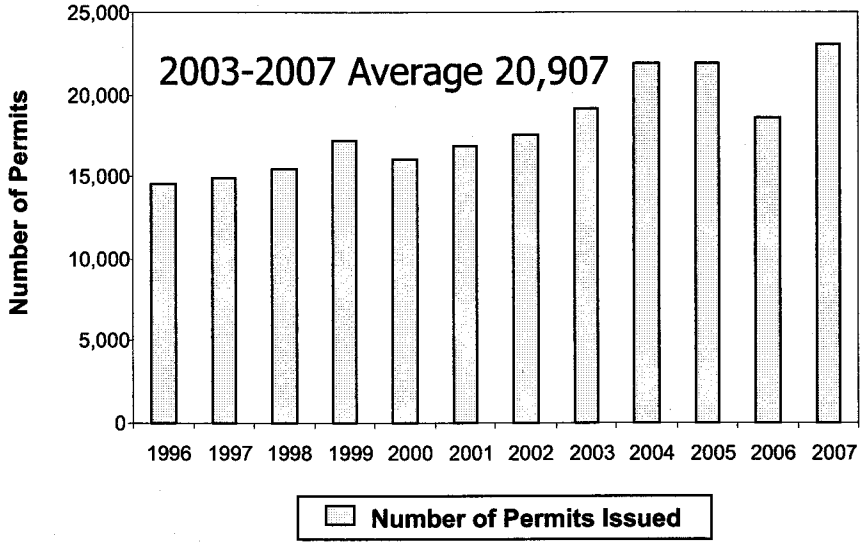
Average Harvest Composition 1996-2001



17

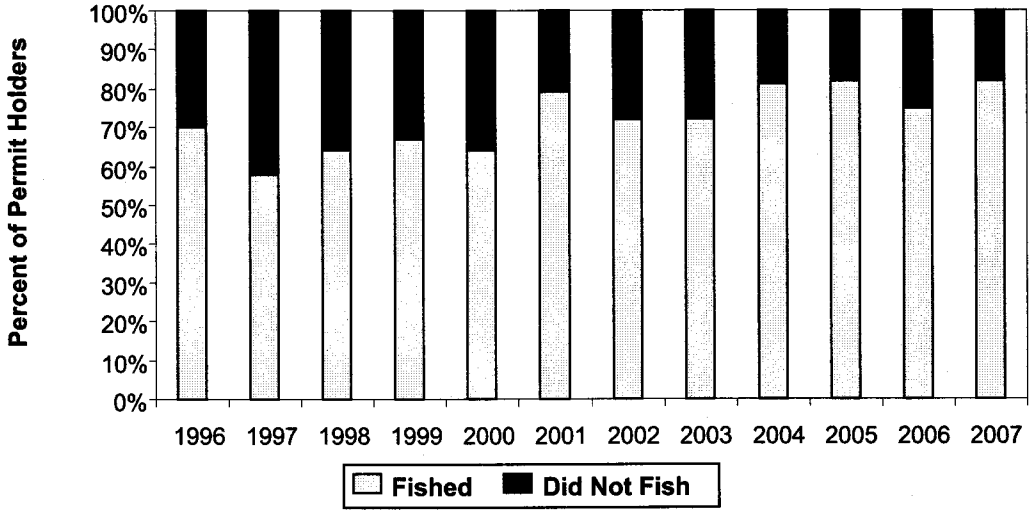


Number of Permits Issued

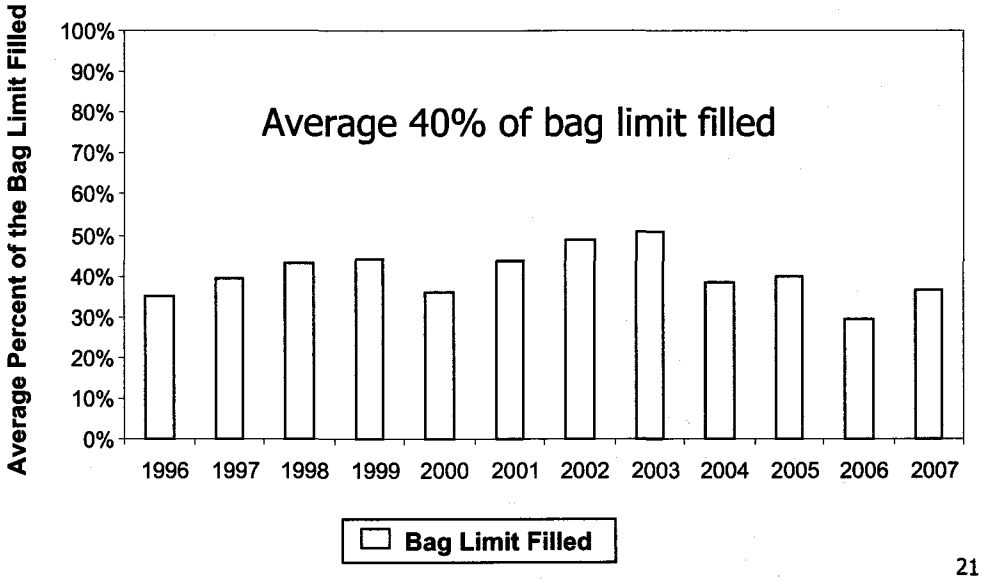


Many do not fish

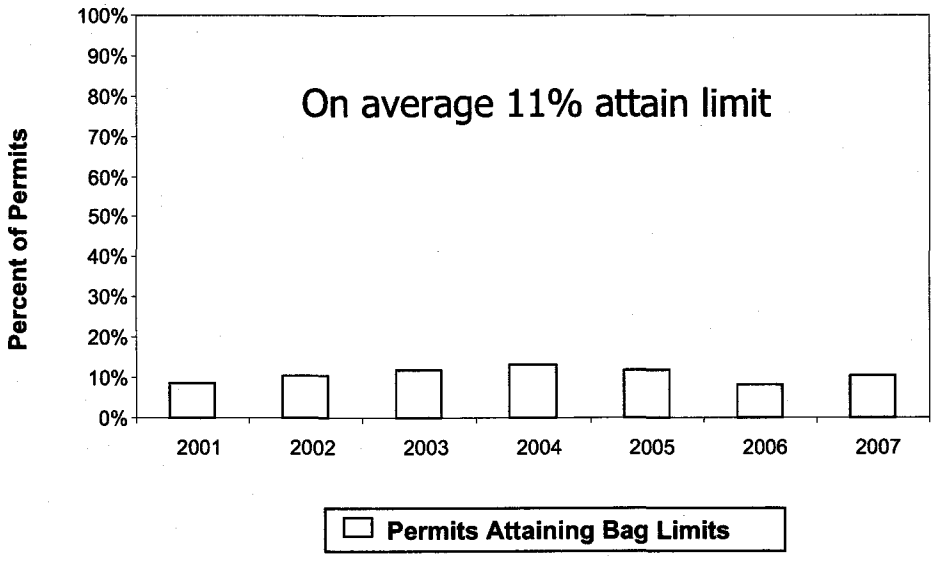
22% ~ 4,500



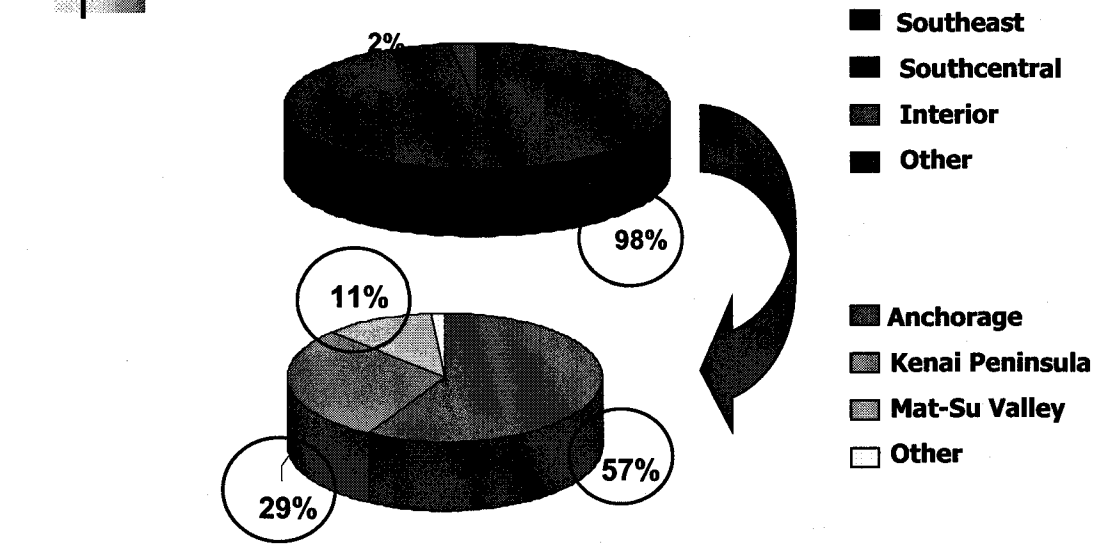
Most do not reach the limit



Few Households Attain Limit



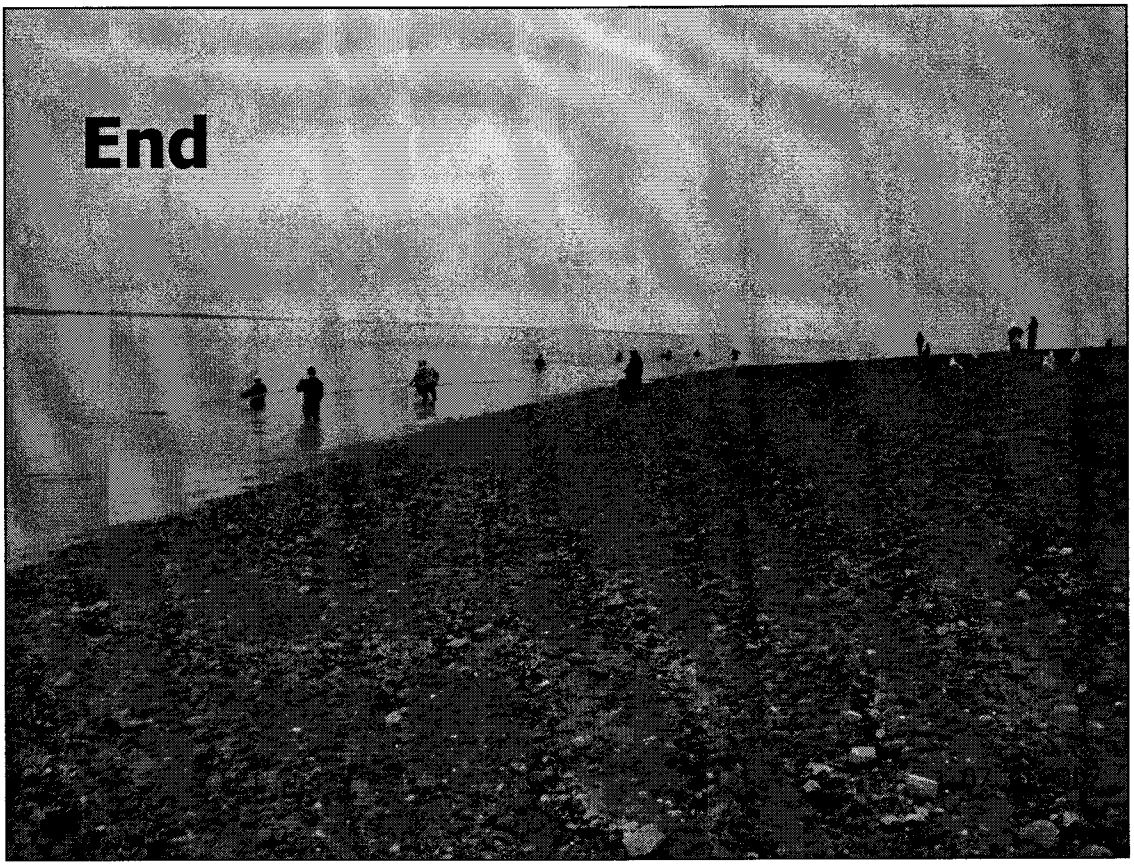
Residency Trends



** Average from 1996-2006.

Summary

- Fisheries open and close on dates and locations specified in regulation giving each fishery a measure of predictability.
- Harvests and participation although variable have overall displayed small incremental growth since 1996.
- Many permit holders do not fish.
- Most permit holders do not attain allowable household bag limit.
- Most permit holders are residents of Anchorage and the Kenai Peninsula Area.


End

Kenai & Kasilof Rivers: Vessels and Motor Use Issues

Jason Pawluk & Robert Begich

Alaska Department of Fish and Game
Division of Sport Fish
Soldotna

RC #4

Tab #6

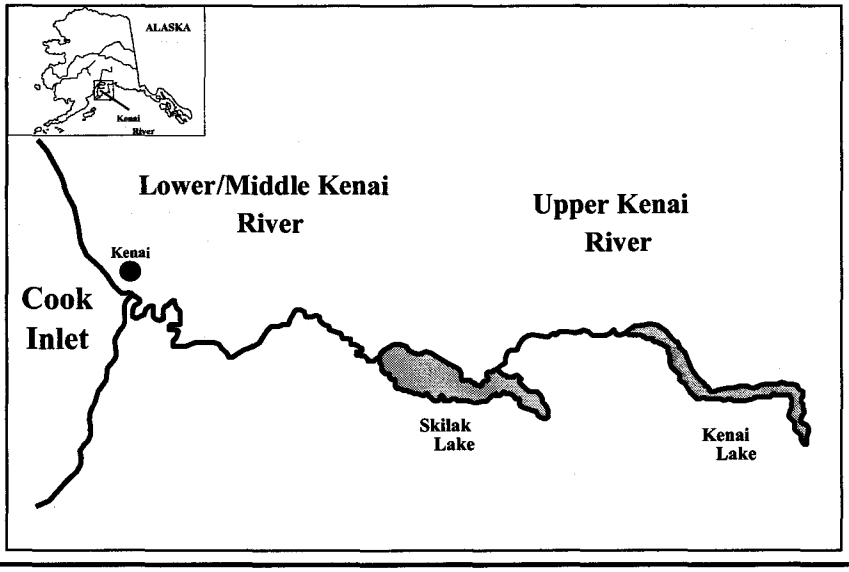
1

Related Proposals (32)

- Kenai River: 221-223, 246, 253, 268 & 269, and 283-301.
- Kasilof River: 228-233

2

Current Kenai River Boating Regulations

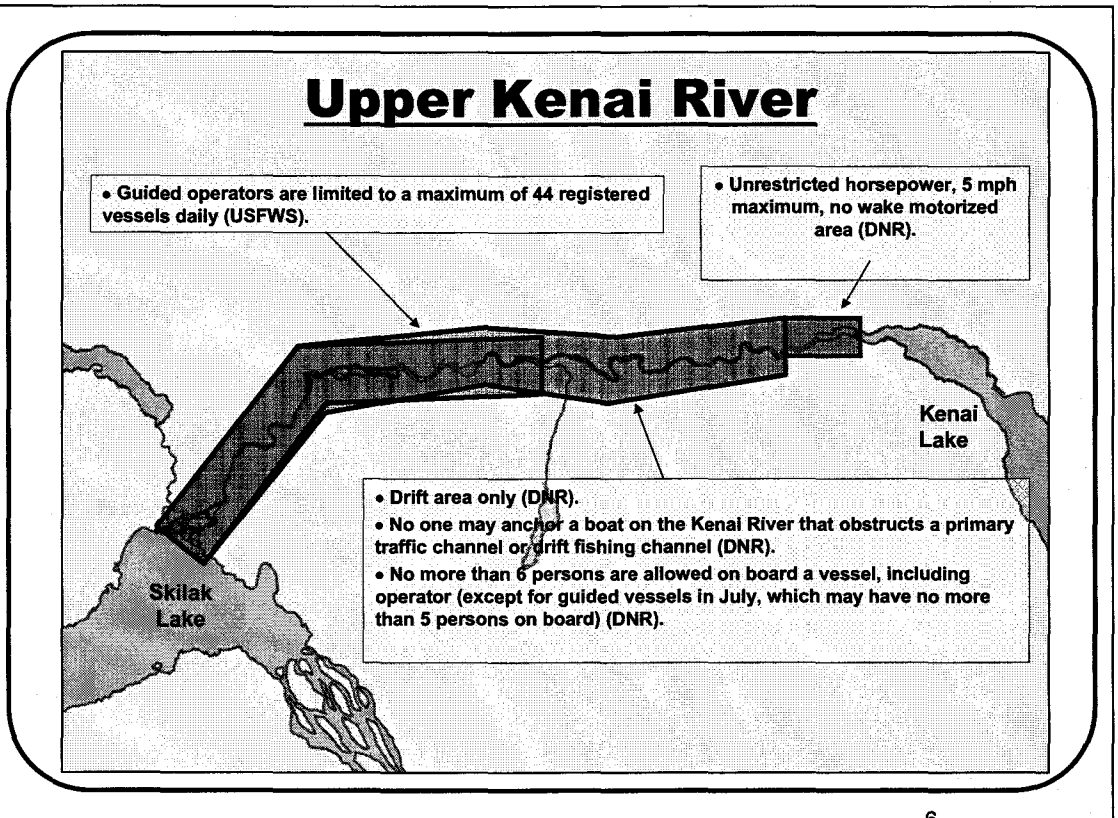


Kenai/Skilak Lakes

- No Regulations

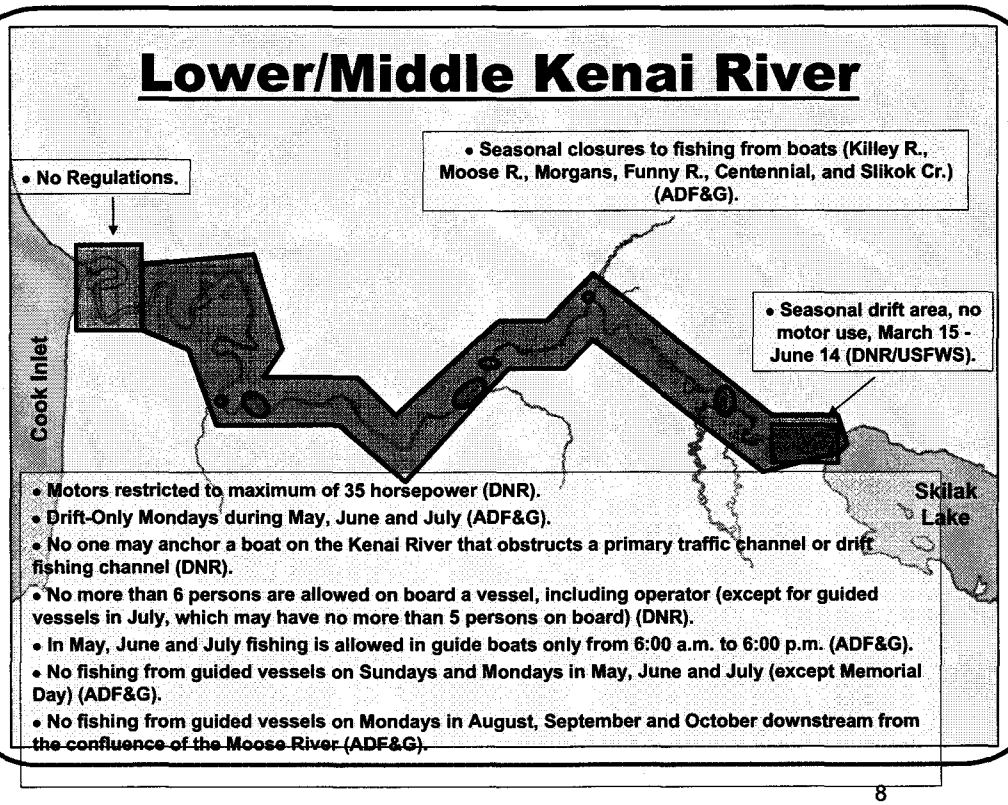
Upper Kenai River

- Unrestricted horsepower 5 mph maximum, no wake motorized area (Kenai Lake – rm 80.7).
- Drift area only (rm 80.7 – Skilak Lake).
- Motors are allowed to be mounted on drift boats in the drift area, but not used.
- No one may anchor a boat on the Kenai River that obstructs a primary traffic channel or drift fishing channel.
- No more than 6 persons are allowed on board a vessel, including operator (except for guided vessels in July, which may have no more than 5 persons on board).
- Guided operators are limited to a maximum of 44 registered vessels daily.



Lower/Middle Kenai River

- Seasonal drift area, no motor use, March 15-June 14 (rm 48.0 – 50.0).
- Motors restricted to maximum of 35 horsepower (rm 5.1 – 50.0).
- Drift-Only Mondays during May, June and July (rm 5.1 – 50.0).
- Seasonal closures to fishing from boats (Killey R., Moose R., Morgans, Funny R., Centennial, and Slikok Cr.).
- No one may anchor a boat on the Kenai River that obstructs a primary traffic channel or drift fishing channel.
- No more than 6 persons are allowed on board a vessel, including operator (except for guided vessels in July, which may have no more than 5 persons on board).
- In May, June and July fishing is allowed in guide boats only from 6:00 a.m. to 6:00 p.m.
- No fishing from guided vessels on Sundays and Mondays in May, June and July (except Memorial Day).
- No fishing from guided vessels on Mondays in August, September and October downstream from the confluence of the Moose River.
- Unrestricted horsepower (rm 0.0 - 5.1).



Kenai River Vessel/Motor Issues

- Hydrocarbon Pollution
- Bank Erosion Caused by Boat Wakes
- Increase in Water Turbidity
- Overcrowding
- Guided vs. Non guided Effort/Catch of King Salmon
- Opportunity for Upstream Anglers to Catch King Salmon
- Non-residents Fishing from Vessels
- Seasonal Closures that Affect Fishing from Vessels
- Increased Motorized Use on the Upper Kenai Near Kenai Lake
- Fishing from Anchored Vessels in Spawning Areas

Drift Boat Mondays

- 1984-1986
  - No fishing from vessels on Mondays after July 5
- 1987-2001
  - No fishing from vessels on Mondays during May, June and July
- 2002-Present
  - Fishing allowed on Mondays from unguided non-motorized vessels

Hydrocarbon Issues

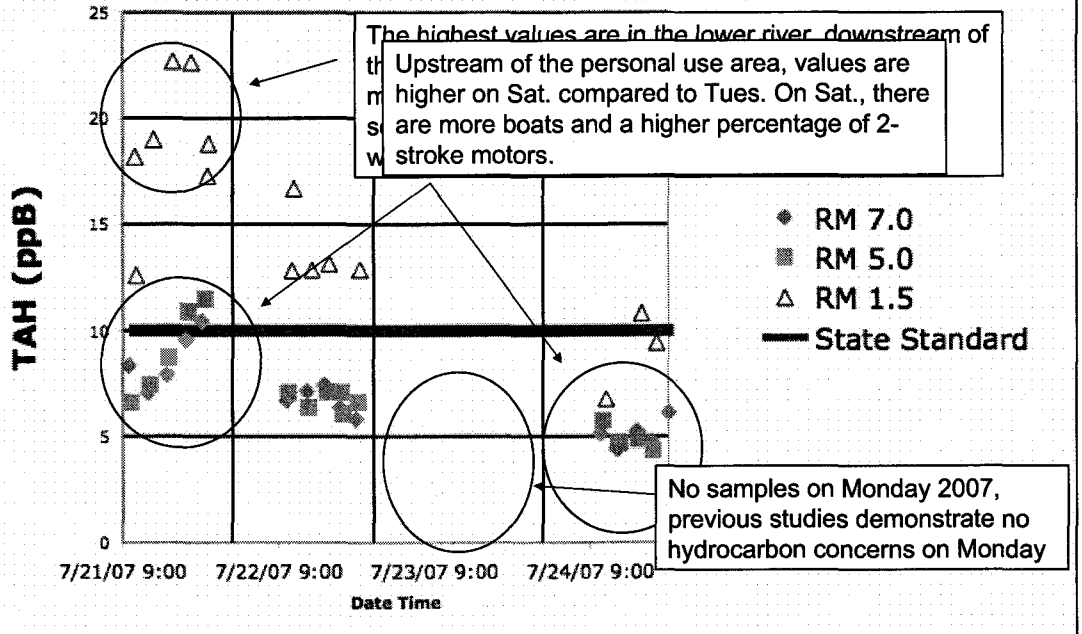
- Gasoline compounds exceed **State** standards every year tested
- Kenai River listed as an impaired water body by DEC in 2006
- Multiple studies demonstrate:
  - Hydrocarbons (HC) are dissolved and mixed in the water column
  - HC [con] correlate strongly # of boats, increases downstream
  - Motor technology is vastly dissimilar, 1 two-stroke = 10+ four-strokes
  - W/ current mix of motors, ~ 350 motors results in an exceedence
- HC [concentration] is proportional to # and type of motors and inversely proportional to the river's water level

1991 - ADFG FRED Report 123

2003 - KWF Fact Sheet NPS-FS-001

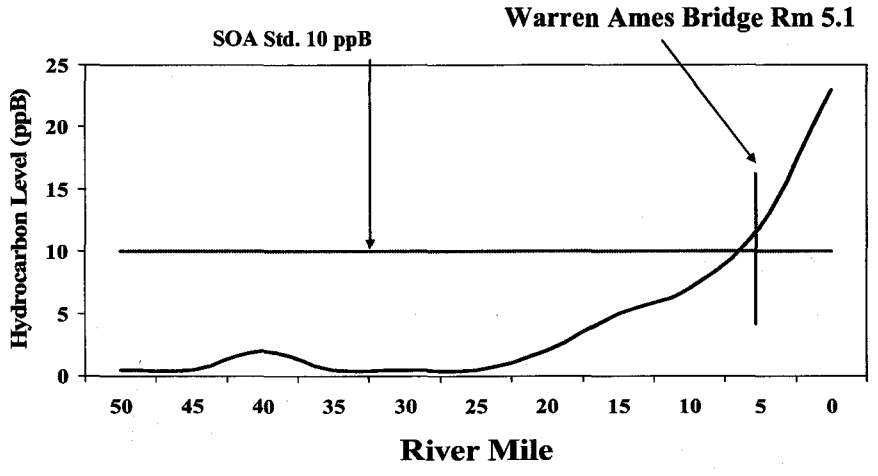
2004 - OASIS Environmental INC Kenai River Hydrocarbon Assessment

2007 Peak Use (Sat. thru Tues.)

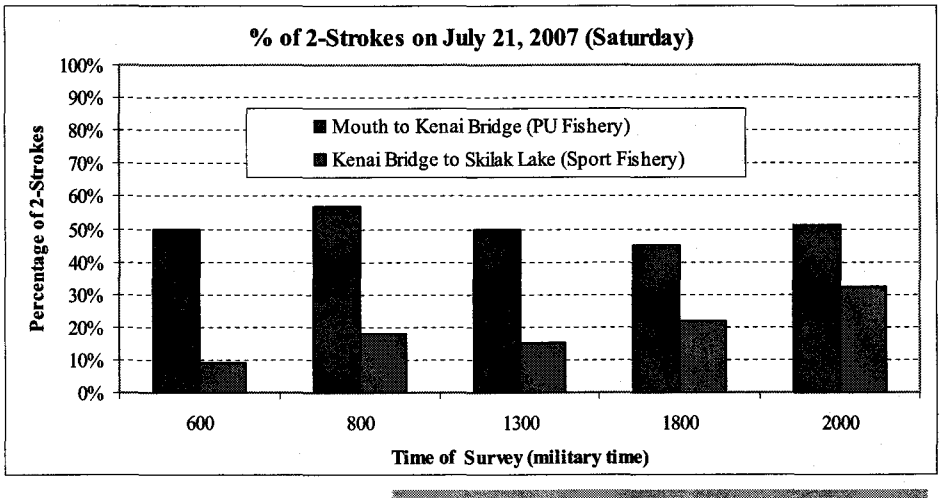


* Data provided by the Kenai River Watershed Forum

Conceptual Diagram of a Peak Use Day, Kenai River



Percentage of 2-Strokes

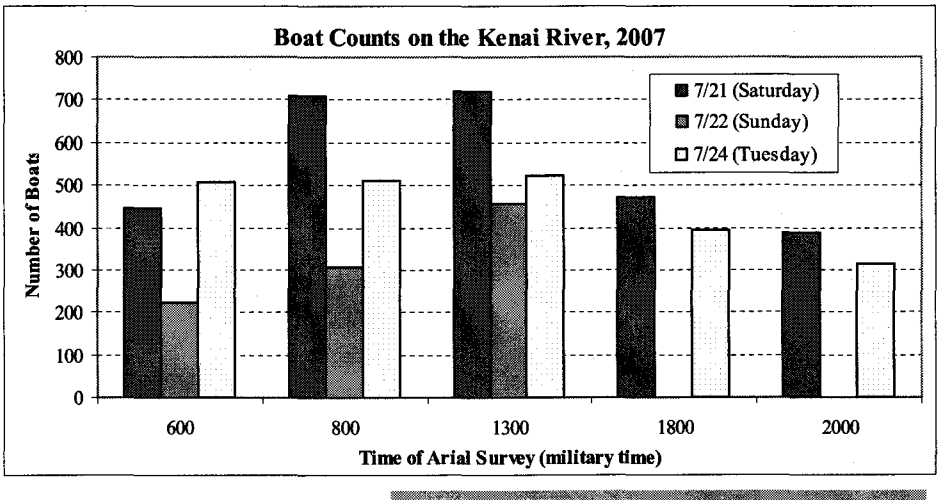


* Data provided by the Kenai River Watershed Forum

Wake Issues

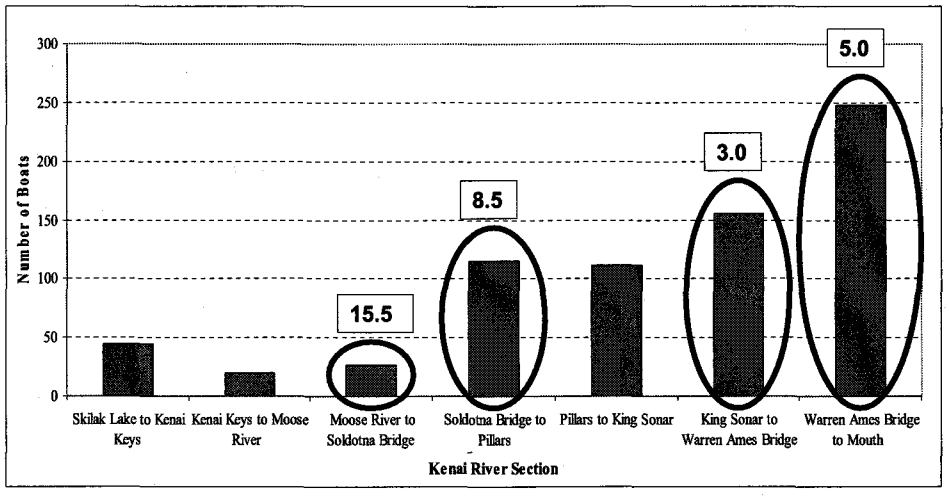
- Two studies conducted by US Army Corps of Engineers
- Wakes do not play a significant role in reshaping channel, large flooding events maintain channel morphology
- Classified and mapped banks relative to susceptibility to wake erosion
- Several recommendations if wake erosion reduction desired
  - Reduce vessel weight
  - Use flat bottom boats
  - Increase power to weight ratio
- Wakes may contribute to turbidity violations of water quality standards

Overcrowding



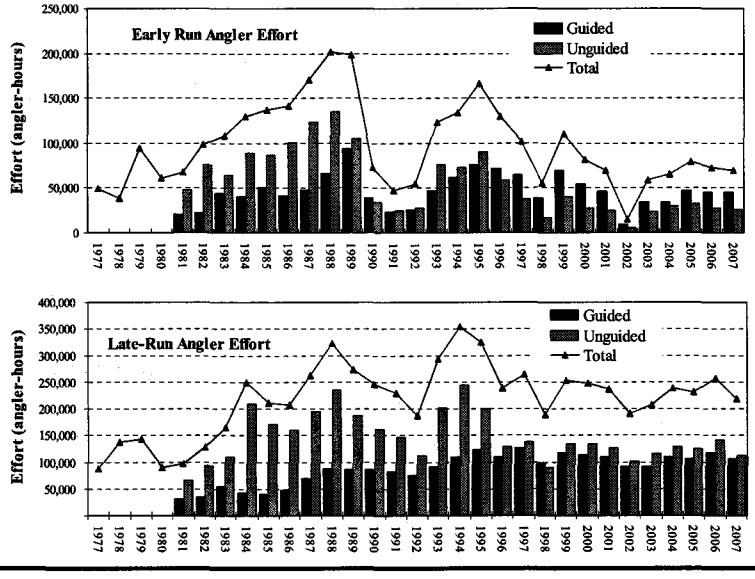
* Data provided by the Kenai River Watershed Forum

Boat Distribution

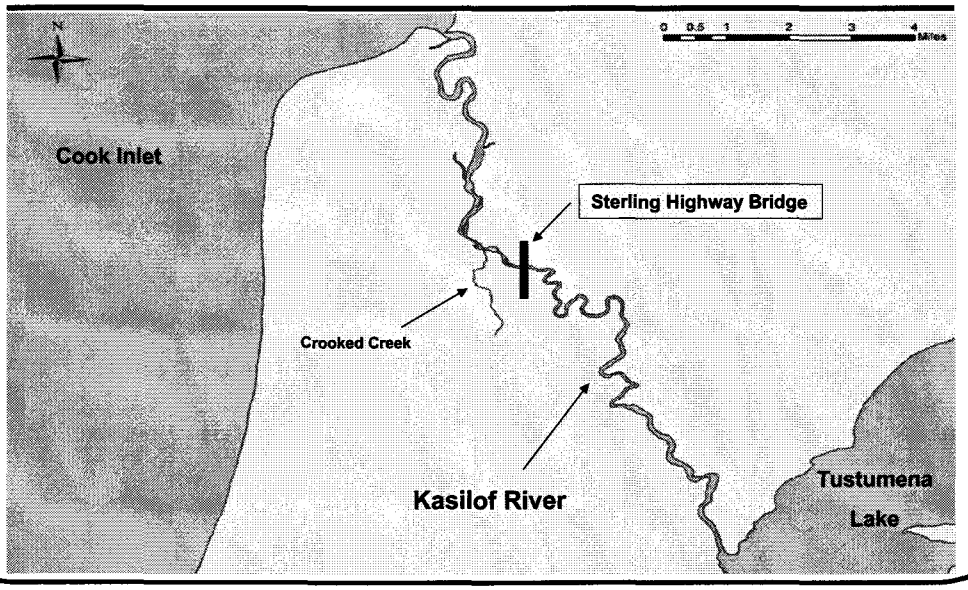


* Data provided by the Kenai River Watershed Forum

Guided vs. Non Guided Effort

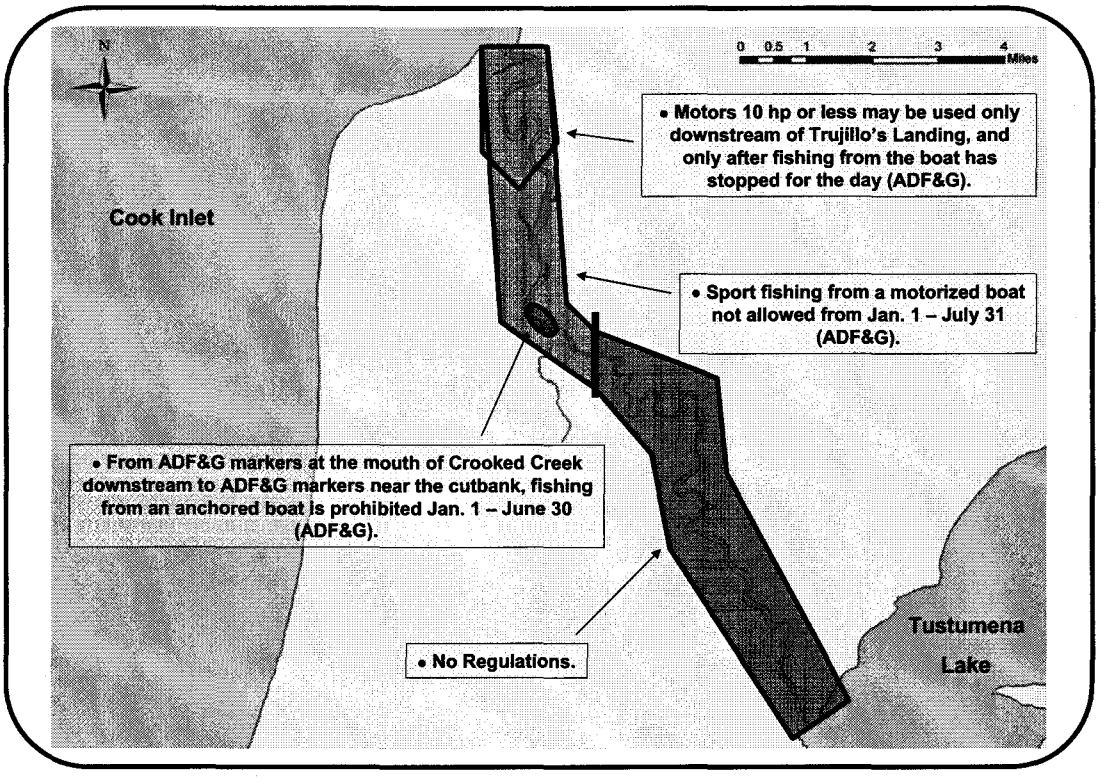


Current Kasilof River Boating Regulations



Kasilof River

- No Regulations (rm 8.0 – Tustumena Lake).
- Sport fishing from a motorized boat not allowed from Jan. 1 – July 31 (Mouth – rm 8.0).
- Motors 10 hp or less may be used only downstream of Trujillo's Landing, and only after fishing from the boat has stopped for the day from Jan. 1 – July 31 (Mouth – rm 3.5).
- From ADF&G markers at the mouth of Crooked Creek downstream to ADF&G markers near the cutbank, fishing from an anchored boat is prohibited Jan. 1 – June 30.



Kasilof River Vessel/Motor Issues

- Establish Spawning Sanctuary for King Salmon in Upper river
- Bank Erosion Caused by Boat Wakes
- Conflict between Drift and Powerboats
- Disturbance of Spawning Beds by Powerboats
- Inadequate Public Access
- Ban on Anchoring in the "Peoples Hole"
- Guided vs. Non guided Effort/Catch of King Salmon

The End

Abundance and Spawner Distribution of Susitna River Sockeye Salmon

by

Richard Yanusz
Division of Sport Fish
Alaska Department of Fish and Game
Palmer Office

Mark Willette
Division of Commercial Fisheries
Alaska Department of Fish and Game
Soldotna Office

Oral Report
RC 4
TAB 7

Acknowledgements

Rick Merizon
Division of Sport Fish
Alaska Department of Fish and Game
Palmer Office

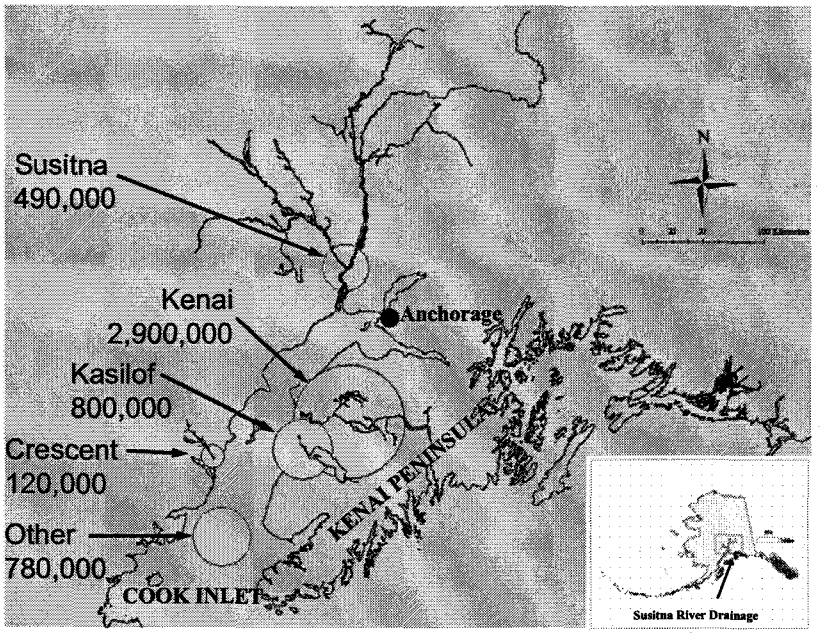
David Evans
Division of Sport Fish
Alaska Department of Fish and Game
Anchorage Office

Ted Spencer
Scott Raborn
Division of Commercial Fisheries
Alaska Department of Fish and Game
Anchorage Office

Cook Inlet Aquaculture Association
"Providing and Protecting Your Salmon Resource"
CIAA

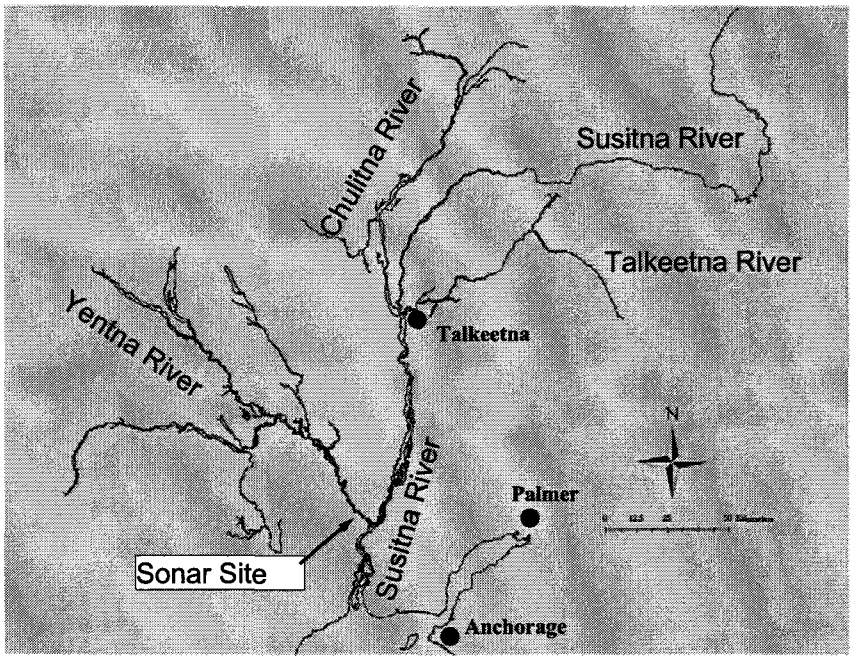
Three-year capital improvement project

Average Total Return of Sockeye Salmon to Major Cook Inlet Drainages



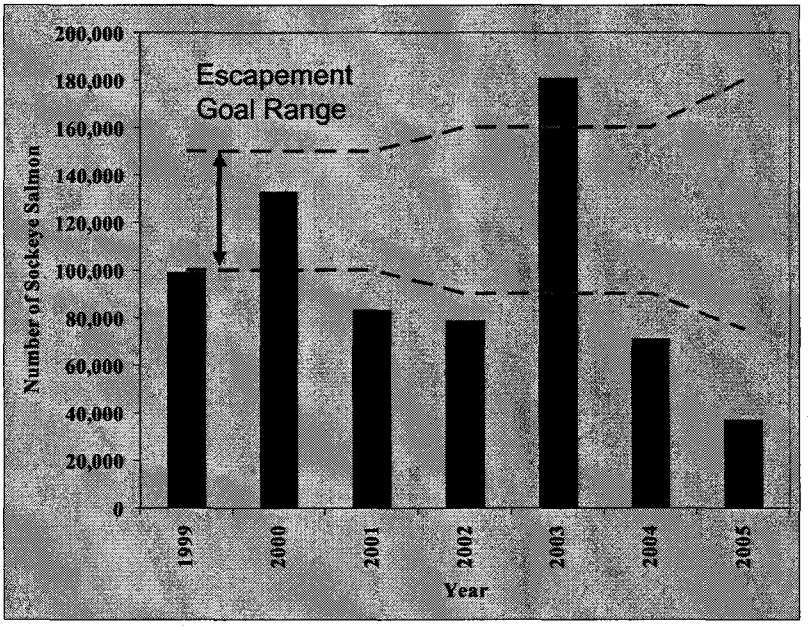
3

Yentna River Sonar Site



4

Yentna Sonar Escapement Estimates



OBJECTIVES

1- Estimate the inriver abundance (escapement) to the entire Susitna River using capture-recapture experiments

2- Identify sockeye salmon spawning areas in the Susitna River

Task

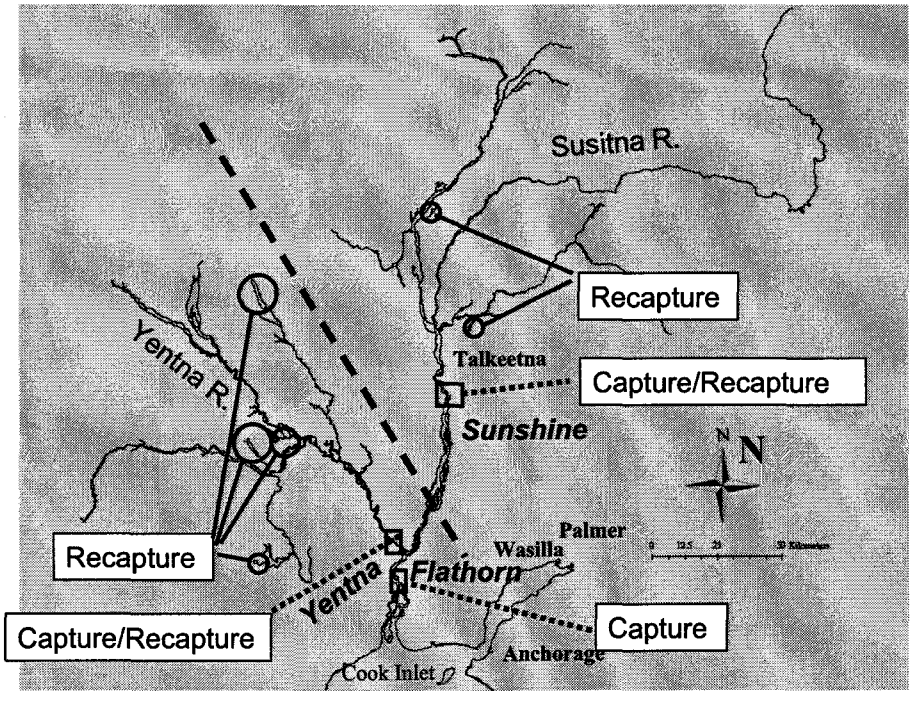
1- Collect tissue samples to expand the genetic baseline

METHODS

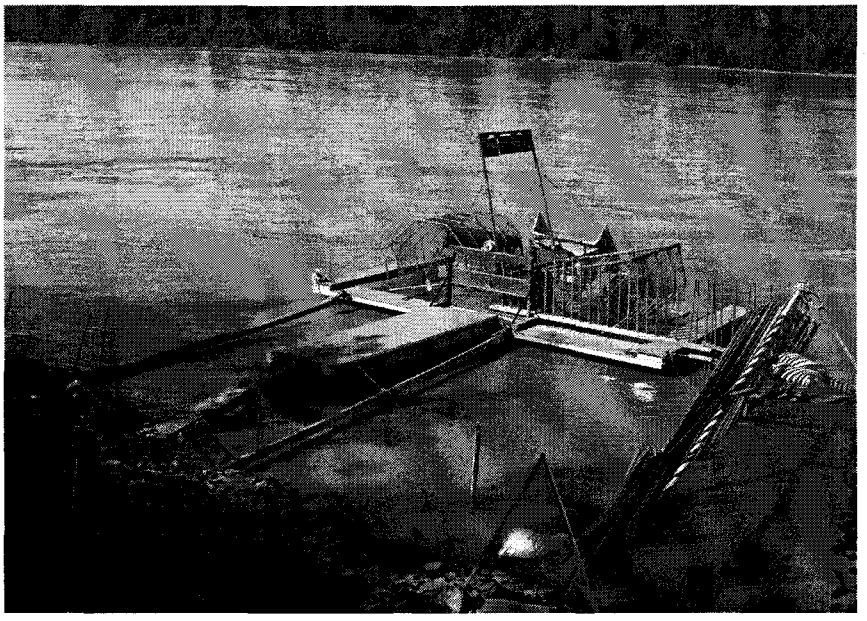
Capture-Recapture Abundance Experiment

1st-CAPTURE **2nd-RECAPTURE**

ABUNDANCE ESTIMATE (NUMBER OF SOCKEYE) = NUMBER TAGGED X (NUMBER EXAMINED / TAGS RECAPTURED)



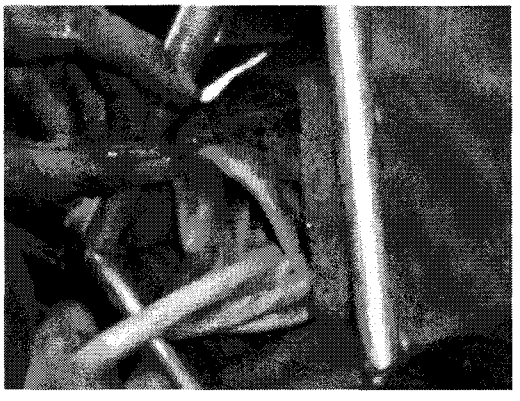
Capture/Recapture



9

Radio Tags

#1



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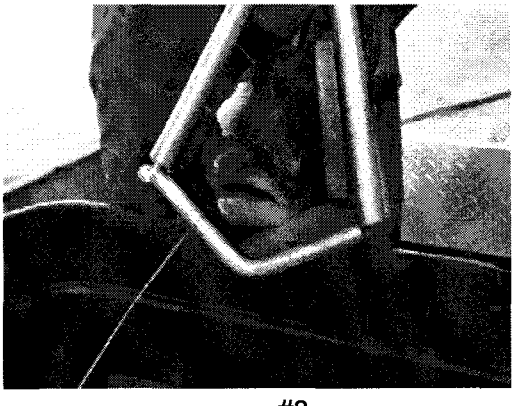
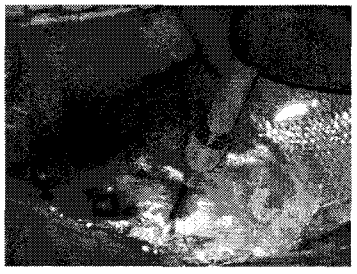


#3

10

PIT Tags

#1



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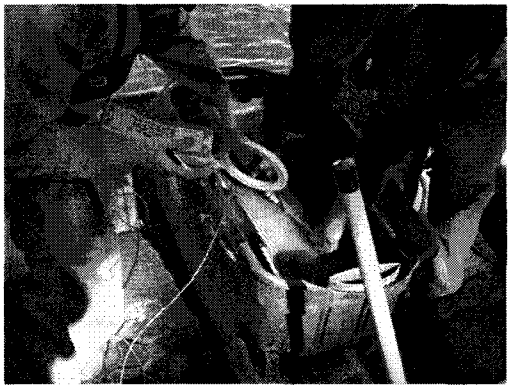


#3

11

Recapture (weirs)

12

Spawning Distribution

RESULTS

Capture-Recapture Abundance Experiment Conditions

a- Equal probability of capture, recapture, or complete mixing

- tags deployed using constant effort
- tagging proportional to catch
- test probability of capture or recapture
- test mixing (time and location of recaptures)

b- No mark-induced behavior (including mortality)

- radio tags moved upstream
- timing of tagged and untagged fish at weirs

c-No tag loss and all tags detected

- radio tags deployed were detected later
- radio tags deployed moved upstream

d- No immigration or emigration between events

- no immigration by design
- movement shown by radio telemetry
- emigration shown by radio telemetry

Abundance-Mainstem Susitna (Sunshine)

Escapement		2006	2007
Sunshine Capture-Recapture (95% C.I.)	Flathorn-Sunshine PIT Tag	107,000 (49,000-165,000)	Not Used
	Sunshine Radio Tag	93,000 (80,000-106,000)	85,000 (preliminary)
	Sunshine-Larson PIT Tag	128,000 (no C.I.)	Not Used

Weir Total		59,519 (2 weirs)	59,901 (4 weirs)
Larson Weir Only (% of Capture-Recapture)		57,411 (54%)	47,736 (56%)

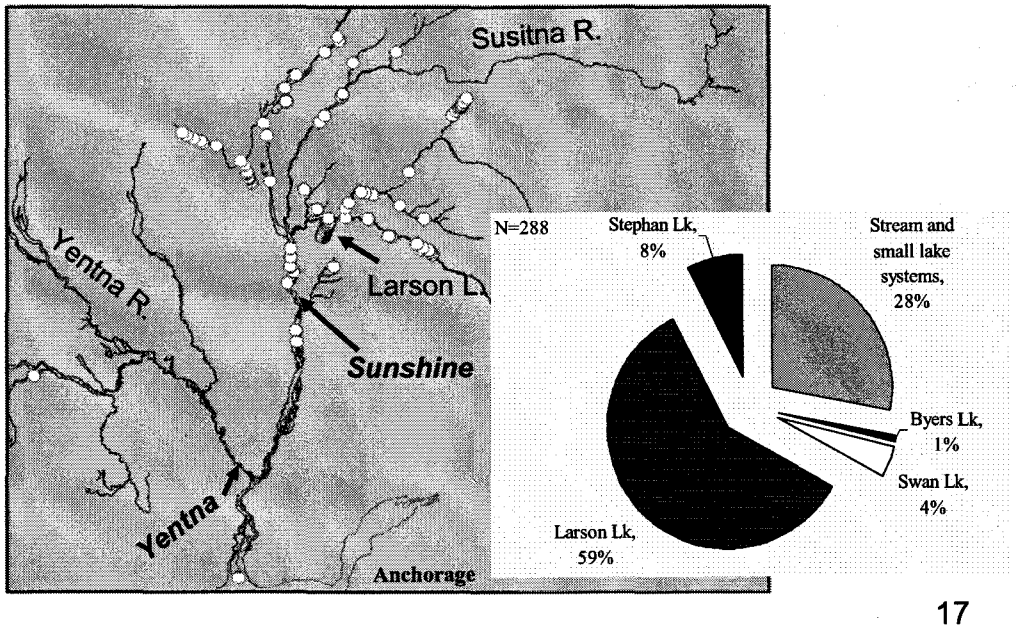
Abundance-Yentna

Escapement		2006	2007
Yentna Capture-Recapture (95% C.I.)	Flathorn PIT Tag 7/29-8/18	418,000 (262,000-574,000)	Not Used
	Radio Tag	311,000 (252,000-391,000)	247,000 (preliminary)

Yentna Weir Total		126,218 (4 weirs)	96,889 (3 weirs)
Bendix Sonar		92,896	79,901
DIDSON Sonar		160,462	130,000 (preliminary)

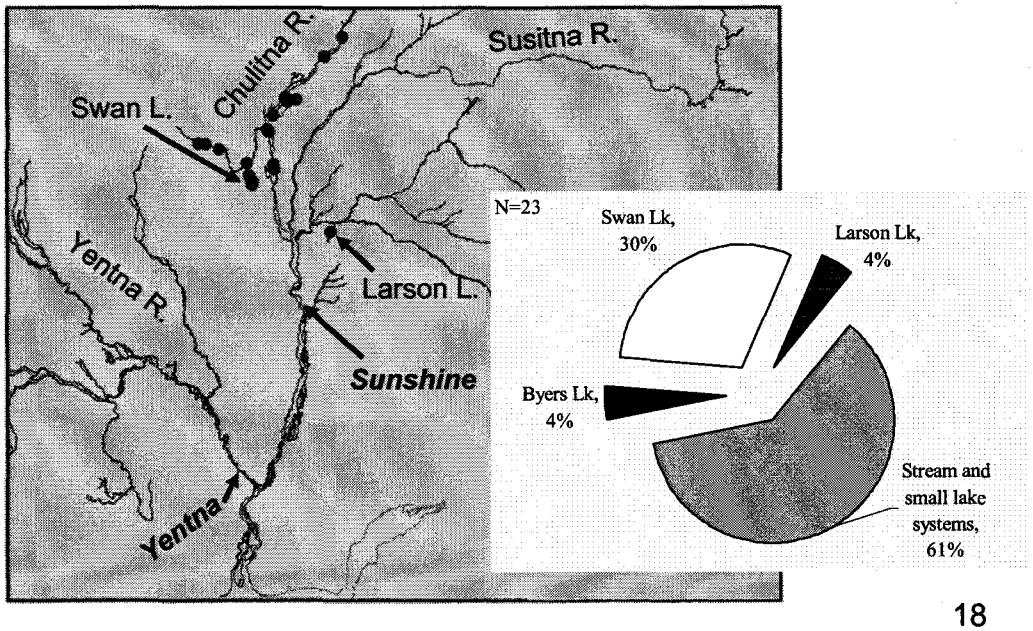
Sockeye Salmon Radio Tag Destinations 2007

Mainstem Susitna (Sunshine – East Bank Wheel)



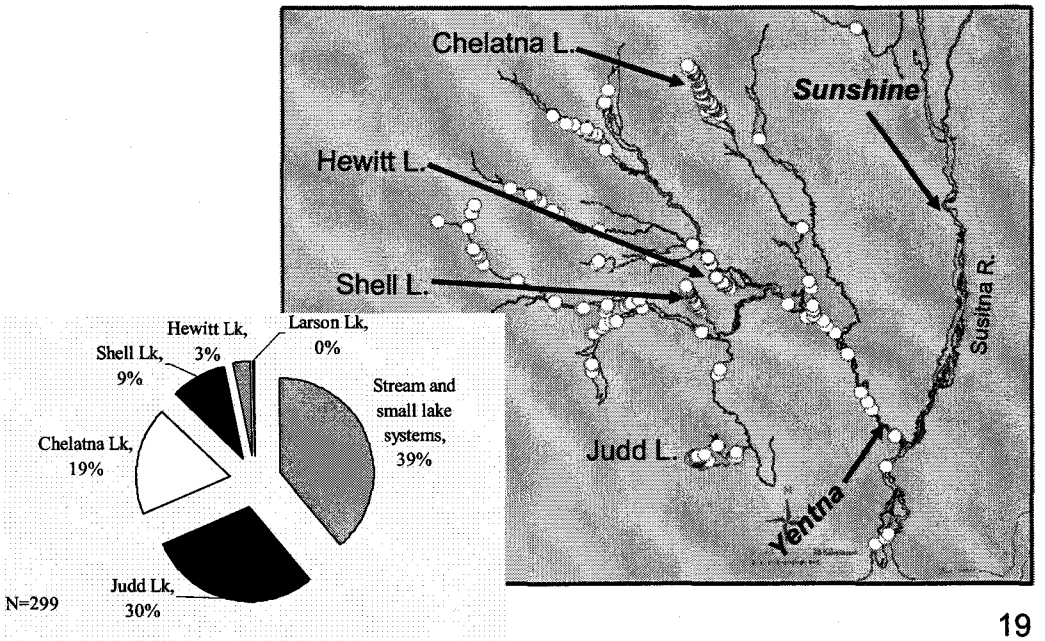
Sockeye Salmon Radio Tag Destinations 2007

Mainstem Susitna (Sunshine – West Bank Wheel)



Sockeye Salmon Radio Tag Destinations 2007

Yentna - South Bank Wheel



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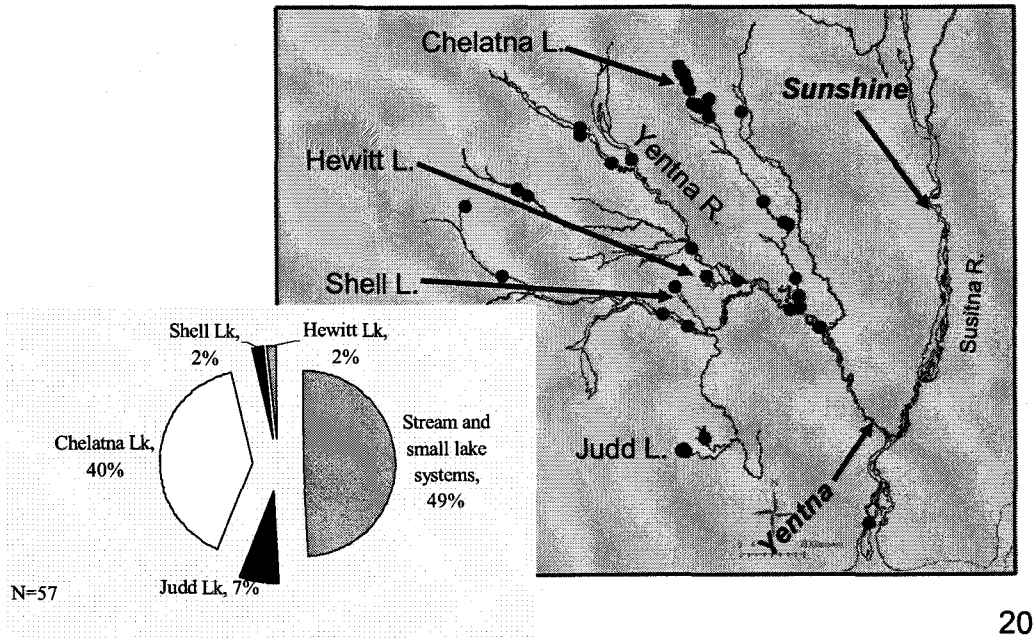
Sockeye Salmon Radio Tag Destinations 2007

Yentna - North Bank Wheel



20

Conclusions

1.-In 2006, similar results were obtained for the Sunshine capture-recapture estimates, but not for the Yentna estimates.

2.-Sockeye salmon spawn mostly in the major lake systems, but a substantial portion spawn in non-lake systems.

3.-Sockeye salmon spawn over a wide area of the Susitna drainage.

4.-Both years, Bendix sonar escapement estimates were lower than the weir counts, while the DIDSON estimates were greater.

Susitna Sockeye Salmon Rearing Lake Investigations

Report to the Alaska Board of Fisheries

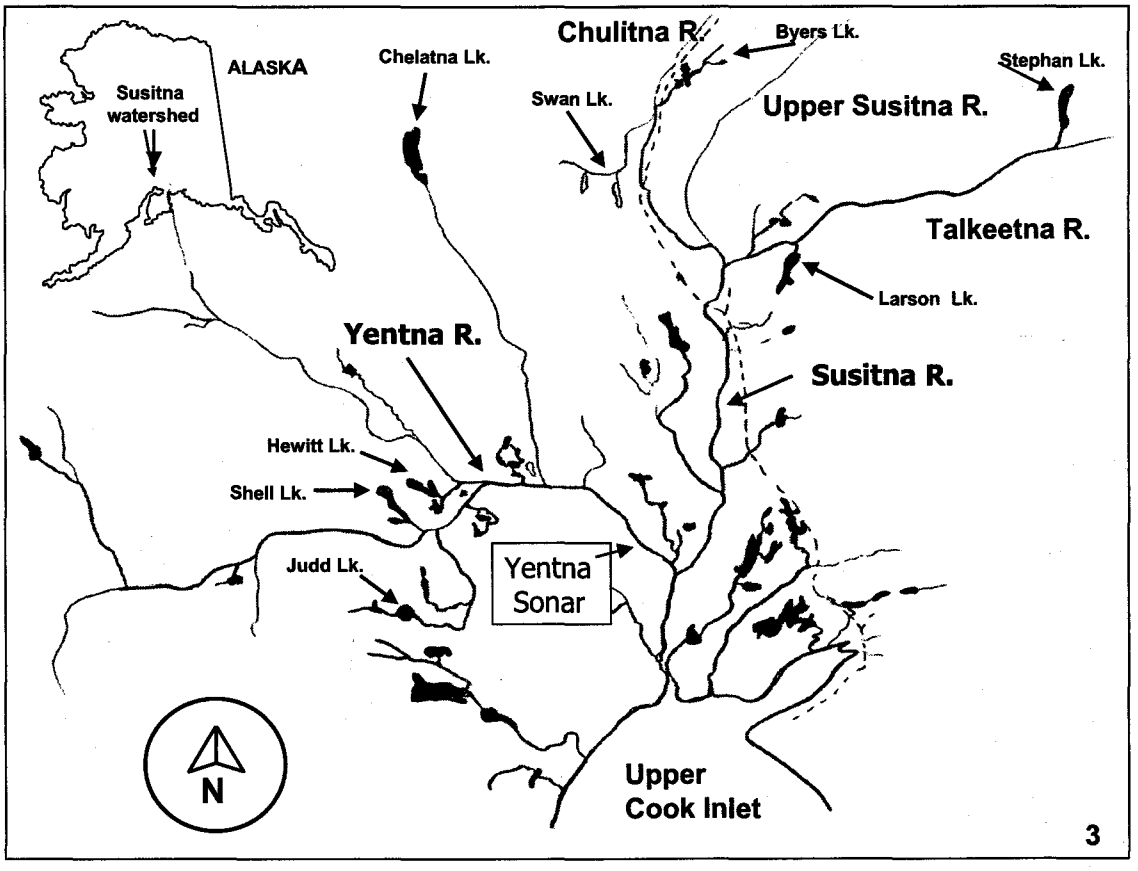
By

Mark Willette, Alaska Dept. of Fish and Game,
Commercial Fisheries Division

Gary Fandrei, Cook Inlet Aquaculture Association

Objectives

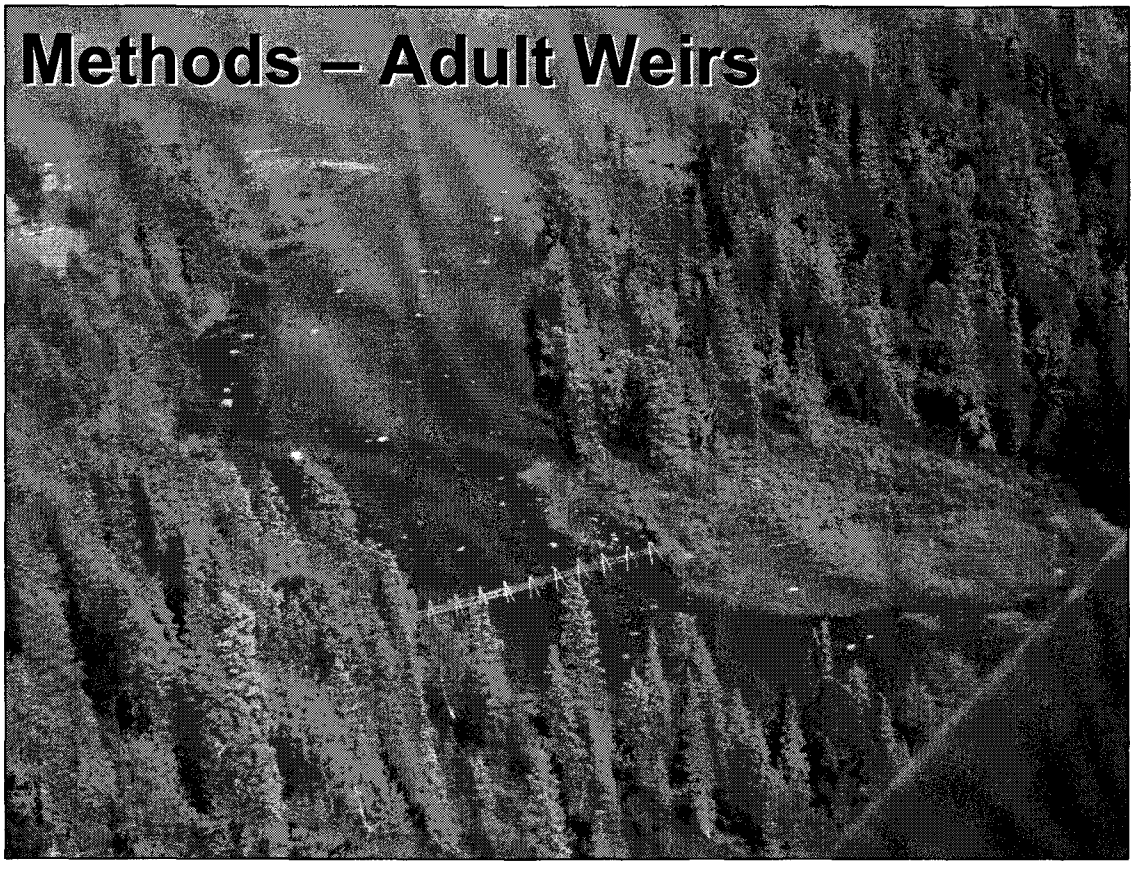
- **Estimate adult sockeye salmon escapement, and fall fry and smolt abundance in the major sockeye salmon rearing lakes in the watershed**
- **Develop life history brood tables to estimate freshwater production of sockeye salmon in each rearing lake**
- **Collect limnological data to evaluate bottom-up limitations to sockeye salmon production in each lake**

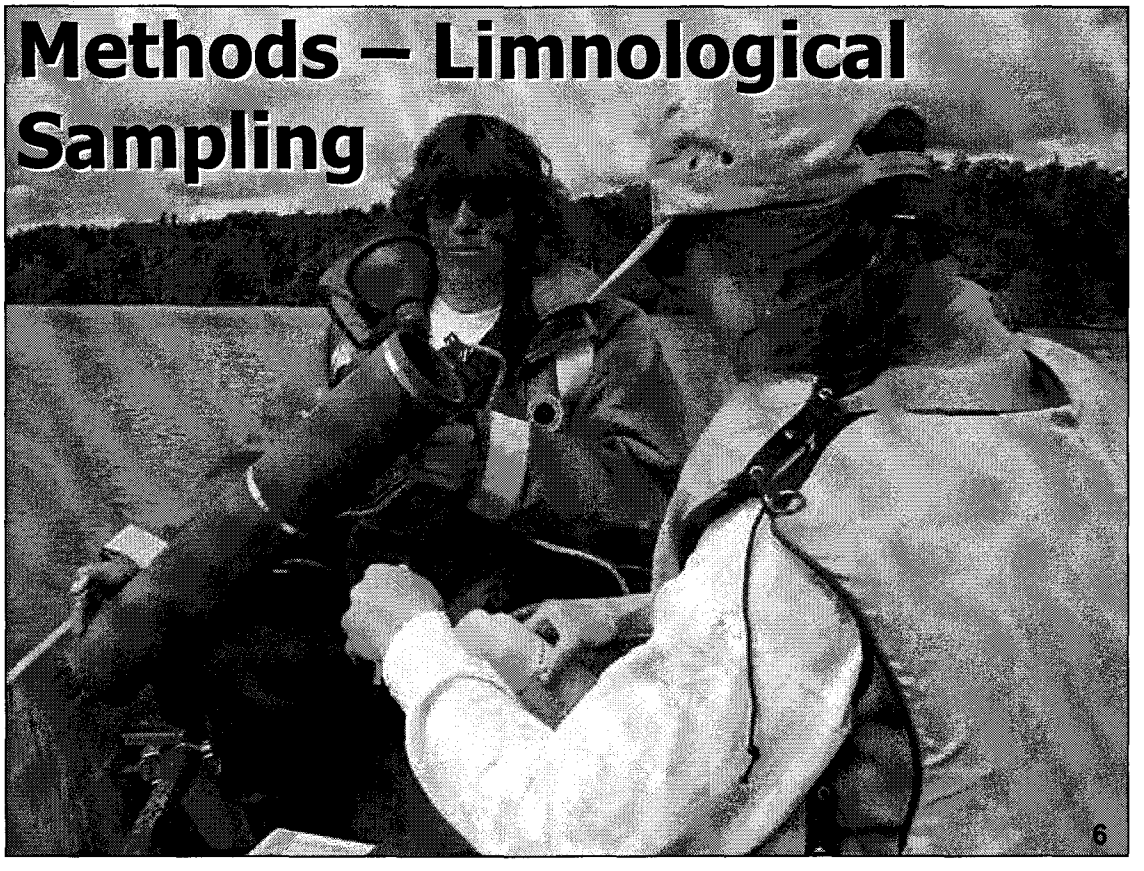


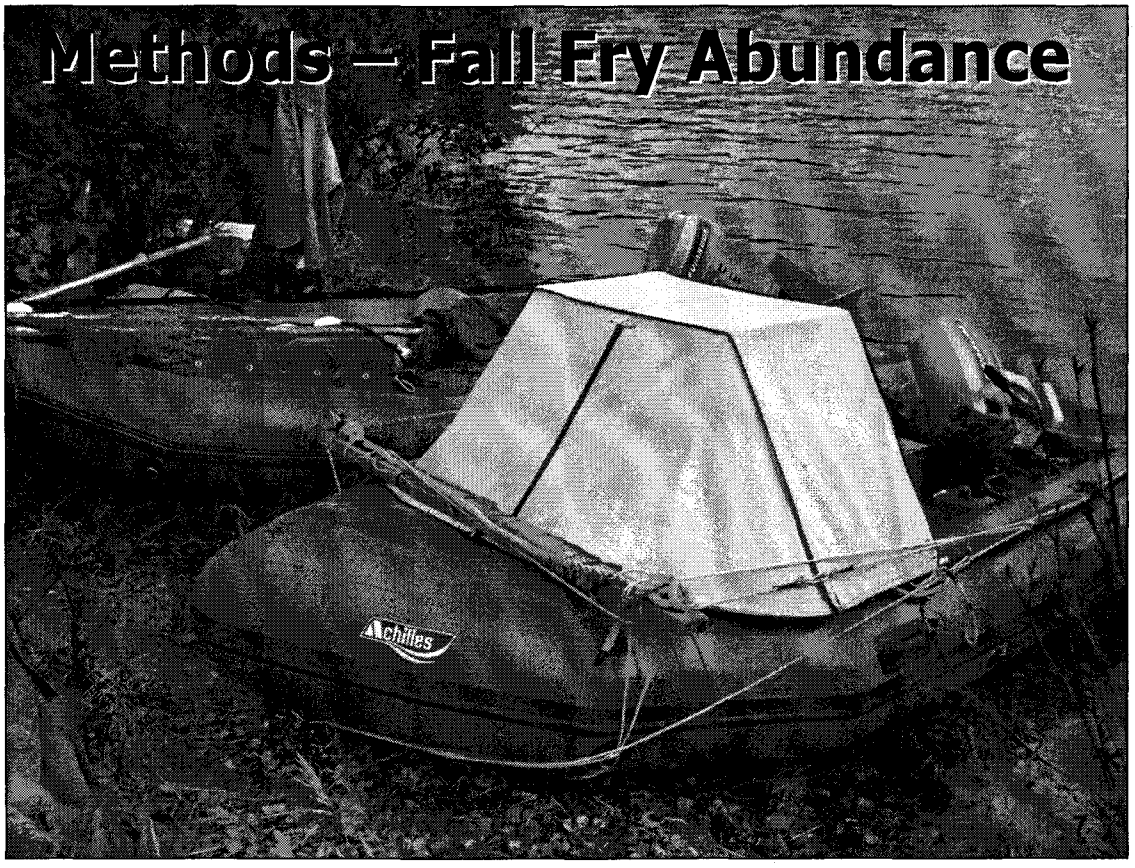
Euphotic Volume Model Estimates of Sockeye Salmon Production

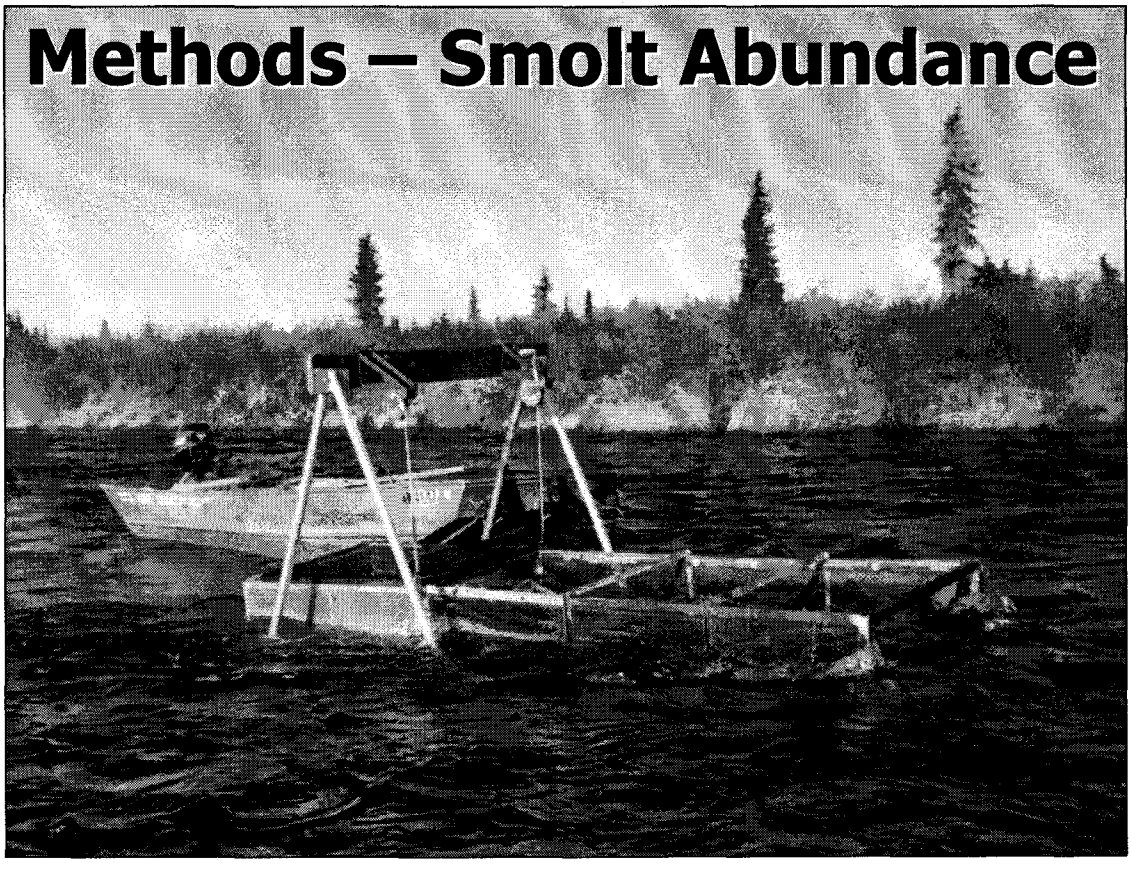
Drainage	Lake	Lake Area (acres)	Adult Production	Percent
Chulitna	Byers	368	37,200	3.80%
	Swan	385	11,000	1.10%
	Spink	252	23,500	2.40%
	Bunco	106	1,600	0.20%
	Total	1,111	73,300	7.60%
Mainstem	Caswell	159	13,700	1.40%
	Trapper	1,188	16,800	1.70%
	Fish	132	10,600	1.10%
	Sucker	273	8,300	0.90%
	Red Shirt	1,272	69,500	7.20%
	Neil	115	7,600	0.80%
	Total	3,139	126,500	13.00%
Talkeetna	Larson	437	45,100	4.60%
	Stephan	899	63,700	6.60%
	Total	1,336	108,800	11.20%
Yentna	Chelatna	3,906	363,574	37.50%
	Trinity	308	19,300	2.00%
	Whiskey	271	23,600	2.40%
	Fish Creek	111	9,000	0.90%
	Shell	1,293	90,265	9.30%
	Puntilla	90	8,800	0.90%
	Eightmile	115	5,600	0.60%
	Movie	110	6,700	0.70%
	Lockwood	233	11,000	1.10%
	Judd	316	59,500	6.10%
	Hewitt	697	60,600	6.20%
	Red Salmon	113	3,400	0.40%
	Total	7,563	661,339	68.20%
	Grand Total	13,149	969,939	100%

4


Methods – Adult Weirs


Methods – Limnological Sampling
6


Methods – Fall Fry Abundance
Achilles


Methods – Smolt Abundance

Mean Physical & Biological Characteristics of Rearing Lakes

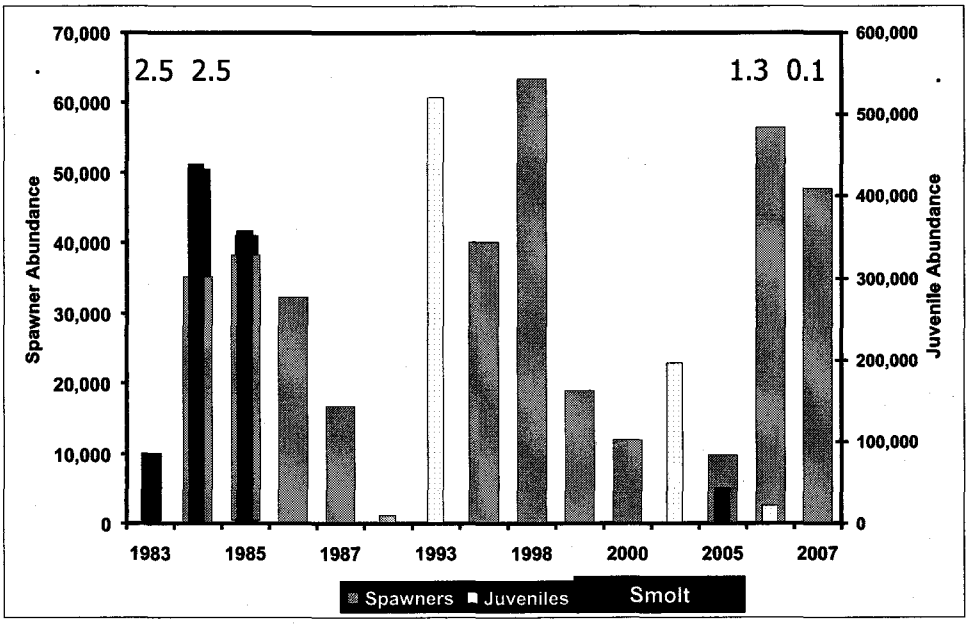
Lake	Lake Area (km2)	Mean Depth (m)	Mean EZD (m)	Euphotic Vol. (10^6 m3)	Mean Temp. (°C)	Zooplankton Biomass (mg/m3)	Fish Density Density (no./m3)	Presence of Pike
Byers	1.5	20.0	10.0	14.9	11.6	27.8	0.010	Absent
Chelatna	16.9	61.0	9.2	155.7	10.7	19.7	0.002	Present
Hewitt	2.8	13.1	8.6	24.3	12.6	13.9	0.078	Present
Judd	1.3	30.0	18.6	23.8	11.2	9.8	0.025	New Arrival
Larson	1.8	16.4	10.2	18.0	13.0	32.1	0.046	Absent
Shell	6.0	11.9	6.9	41.5	12.9	37.9	0.032	Present
Stephan	3.6	7.0	7.0	25.5	11.3	65.0	0.014	Absent
Swan	1.6	ND	2.8	4.4	12.4	ND	ND	Absent

Comparison of Actual Escapements and EV Model Estimates

Year	Yentna R.	Judd	Shell	Hewitt	Chelatna	Larson	Stephan	Byers	Swan	Total
1981	139,401									
1982	113,847									
1983	104,414									
1984	149,375	18,104				35,254				
1985	107,124					37,874				
1986	92,076		4,237			32,322				
1987	66,054					16,753				
1988	52,330									
1989	96,269	12,792								
1990	140,290									
1991	109,632									
1992	66,074				35,300					
1993	141,694				20,235					
1994	128,832				28,303					
1995	121,220				20,104					
1996	90,660				28,684					
1997	157,822				84,899	40,282				
1998	119,623	34,416			27,284	63,514				
1999	99,029					18,943				
2000	133,094					11,987				
2001	83,532									
2002	78,591									
2003	180,813									
2004	71,281									
2005	36,921					9,751				
2006	92,051	40,633	69,720	2,507	13,266	56,445		3,074		
2007	79,901	58,134	26,784		11,671	47,819	4,320	1,701	5,509	
Average	105,598	32,816	33,580	2,507*	36,254	33,722	4,320	2,388	5,509	151,096
EV_Return	661,339	59,500	90,265	60,600	363,574	45,100	63,700	37,200	11,000	730,939
EV_Spawners	165,335	14,875	22,566	15,150	90,894	11,275	15,925	9,300	2,750	182,735

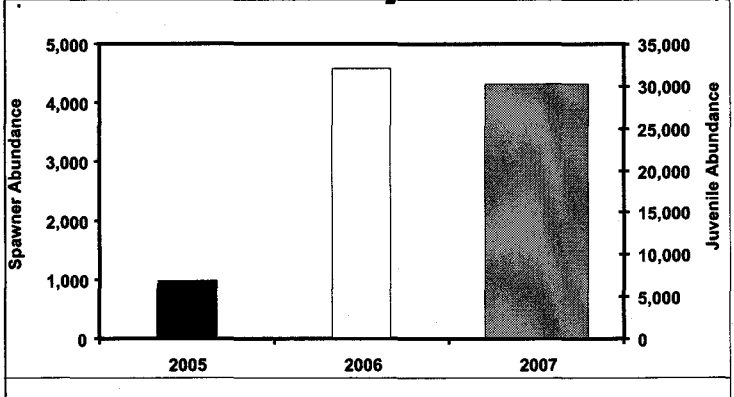
* Partial weir counts indicated in red.

Sockeye Salmon Production
Larson Lake

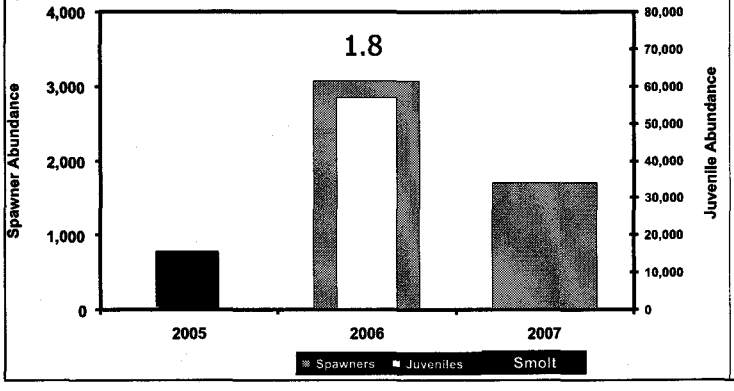


Sockeye Salmon Production

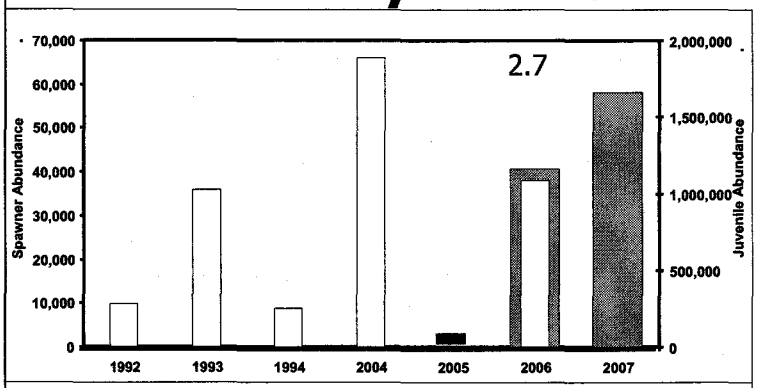
Stephan Lake



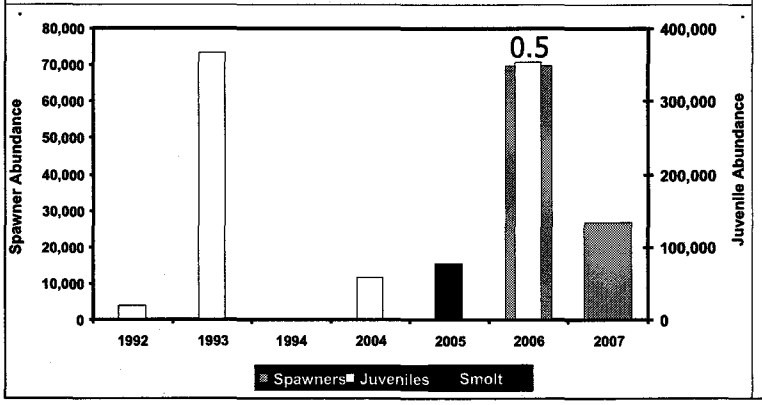
Byers Lake



Sockeye Salmon Production

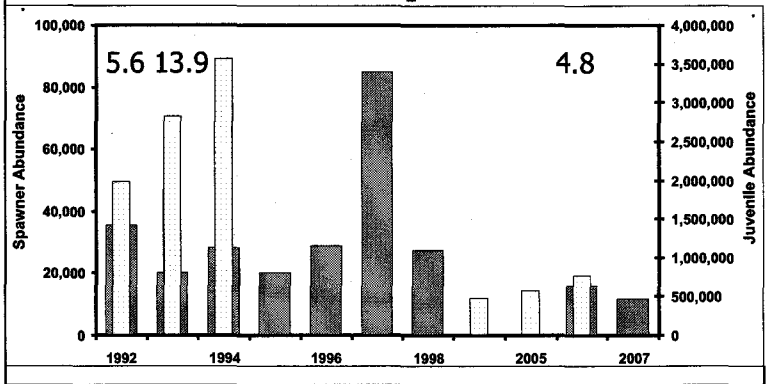


Judd Lake

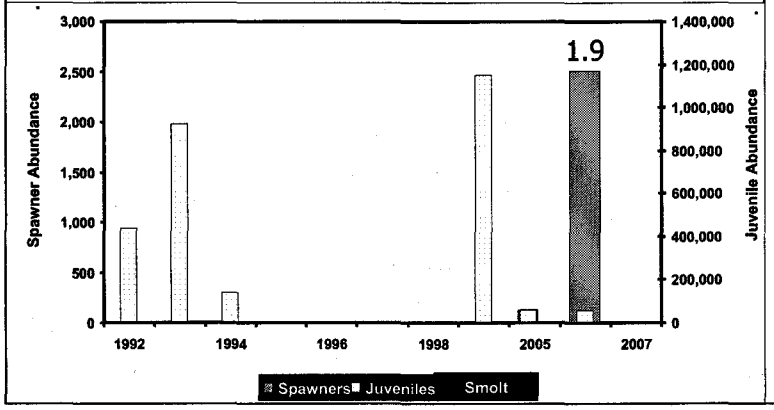


Shell Lake

Sockeye Salmon Production



Chelatna Lake



Hewitt Lake

Estimated Adult Sockeye Salmon Production from 2005 Year Class

Drainage	Lake	Lifestage	Juvenile Abundance	Estimated No. Adults
Susitna	Larson	Smolt	44,751	12,843
	Stephan	Smolt	6,455	2,365
	Byers	Smolt	15,452	4,568
	Lake Total		66,658	19,776
	Fraction in Lakes			0.64
	Susitna Total			30,899
Yentna	Judd	Smolt	9,155	2,117
	Shell	Smolt	76,826	26,121
	Chelatna	Fall Fry	577,709	57,771
	Hewitt	Smolt	7,854	1,901
	Lake Total		804,861	87,909
	Fraction in Lakes			0.54
	Yentna Total			161,597
Total Susitna Watershed				192,497

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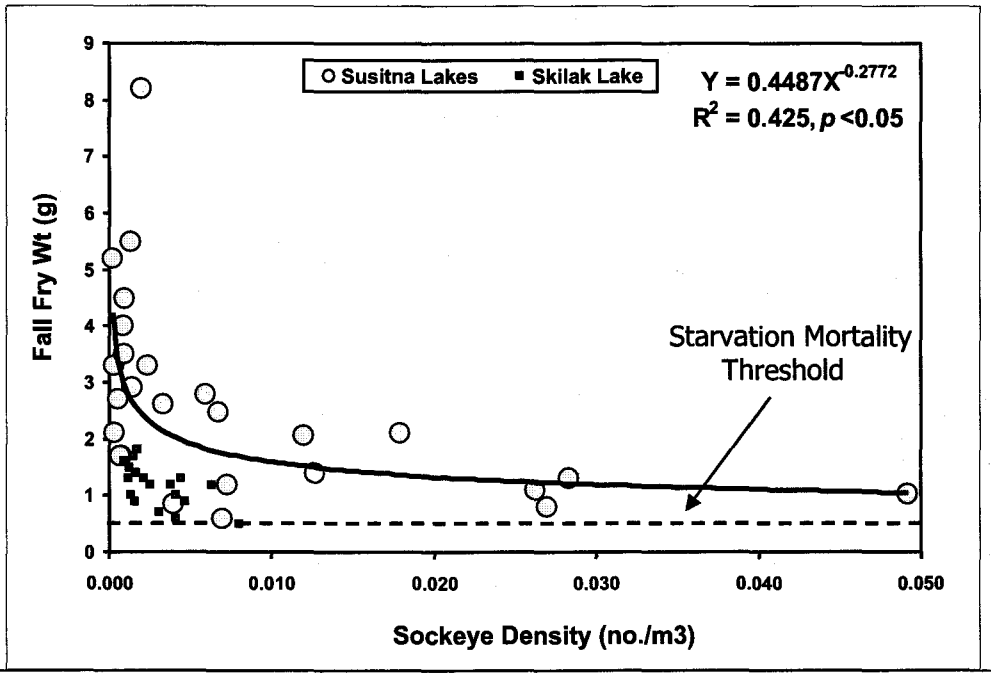
Density-Dependent Fall Fry Growth



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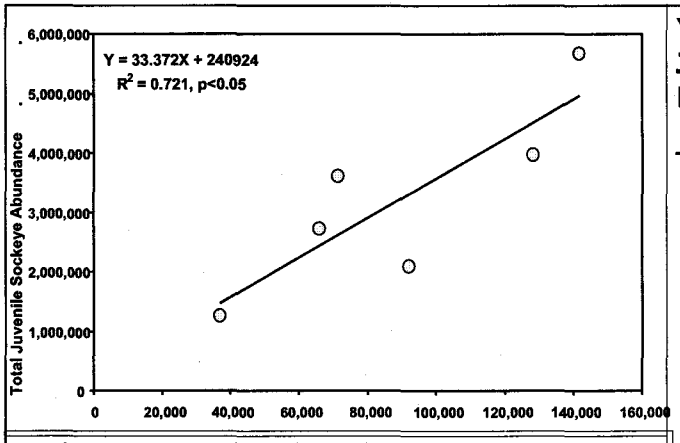
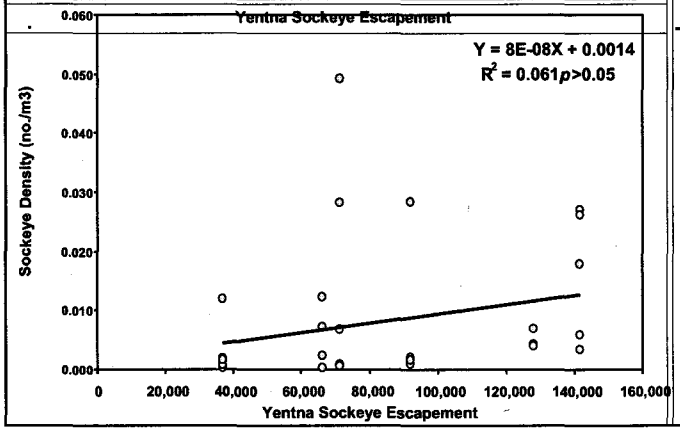
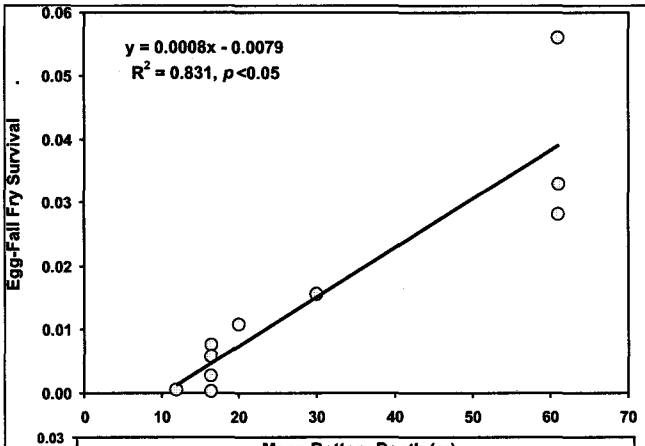


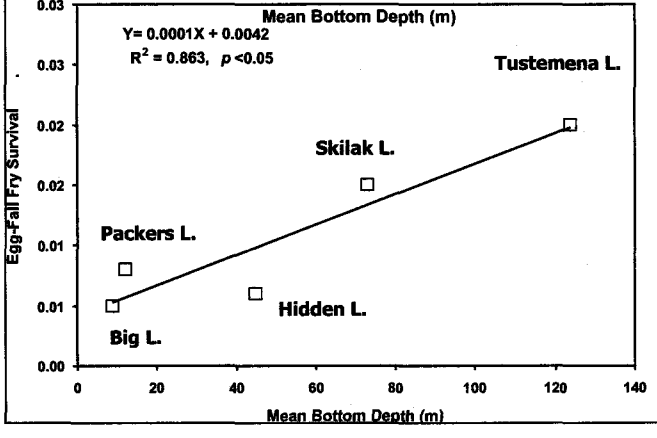
Yentna Sockeye Escapement & Juvenile Abundance in Rearing Lakes

-Aggregate juvenile sockeye salmon abundance in rearing lakes is significantly correlated with Yentna sockeye salmon escapement



-Juvenile sockeye salmon densities in individual rearing lakes are highly variable and not correlated with Yentna sockeye escapement

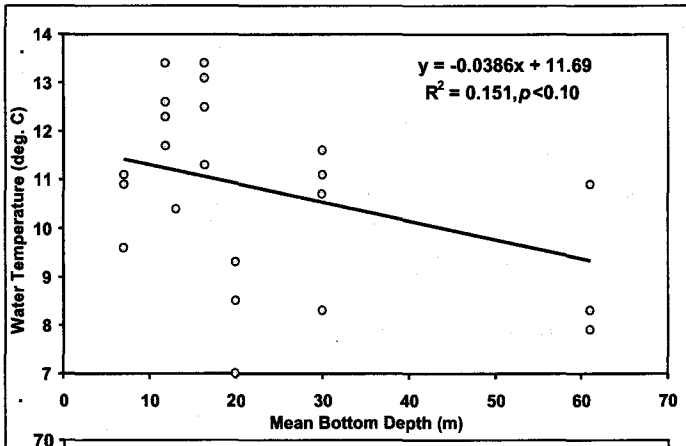


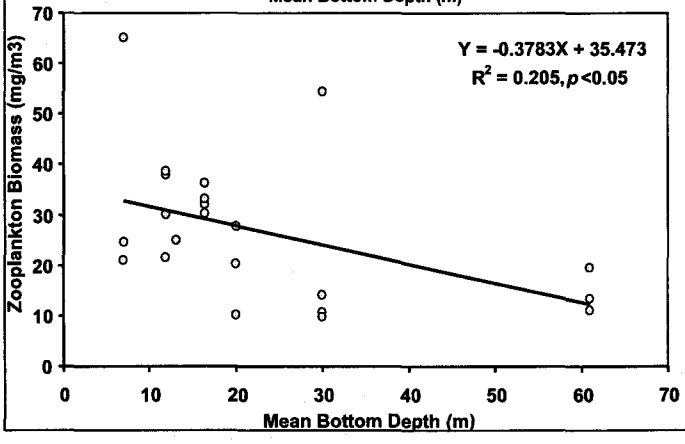


Egg-to-Fall Fry Survival and Lake Habitat Type

-Egg-fry survival was significantly lower in shallower lakes in the Susitna watershed

-Egg-fry survival was also significantly lower in shallower lakes throughout Cook Inlet

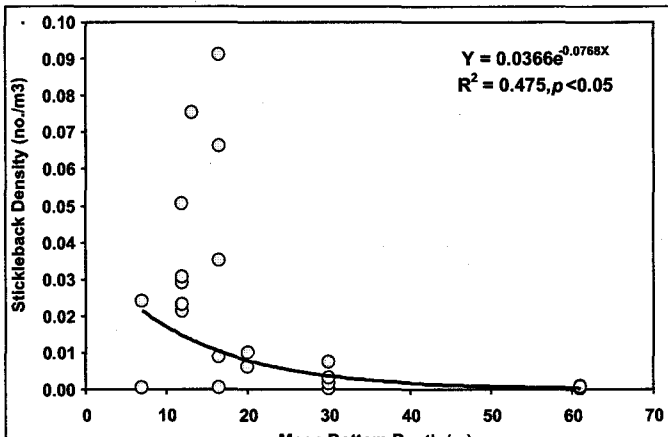


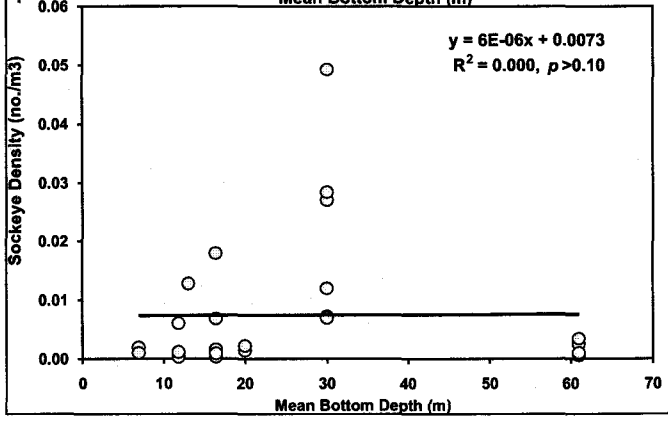


Physical & Biological Characteristics of Lakes and Habitat Type

-Water temperatures were significantly higher in shallower lakes

-Zooplankton biomass was also significantly higher in shallower lakes

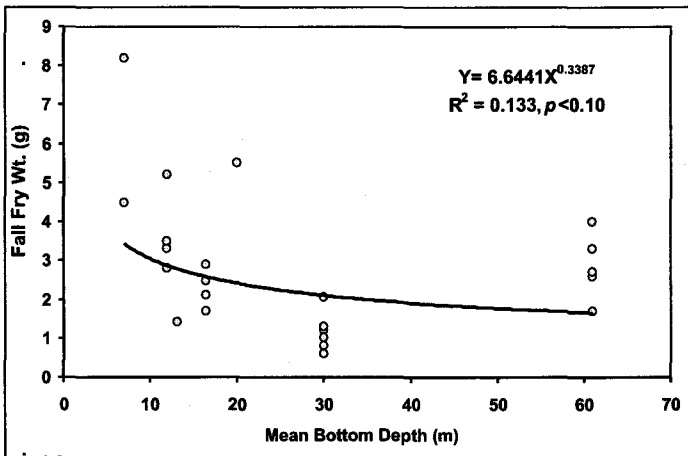


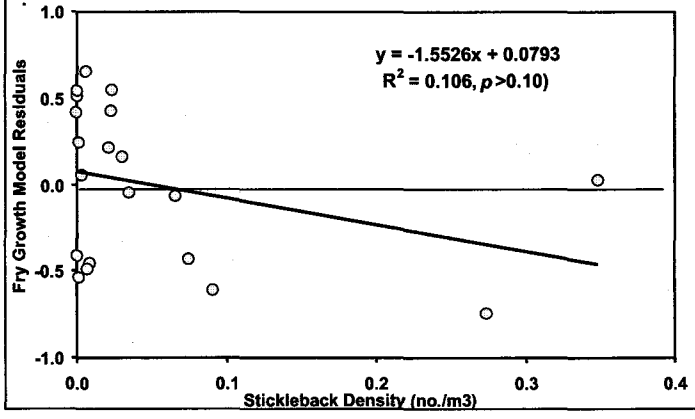


Pelagic Fish Densities and and Habitat Type

-Stickleback densities were significantly higher in shallower lakes

-Sockeye salmon densities were not significantly higher in shallower lakes





Sockeye Fry Growth in Relation to Habitat and Stickleback Densities

-Fall fry weight was significantly higher in shallower lakes

-Fall fry weight was weakly correlated with stickleback densities

-These relationships suggest that predation losses may be higher in shallower lakes

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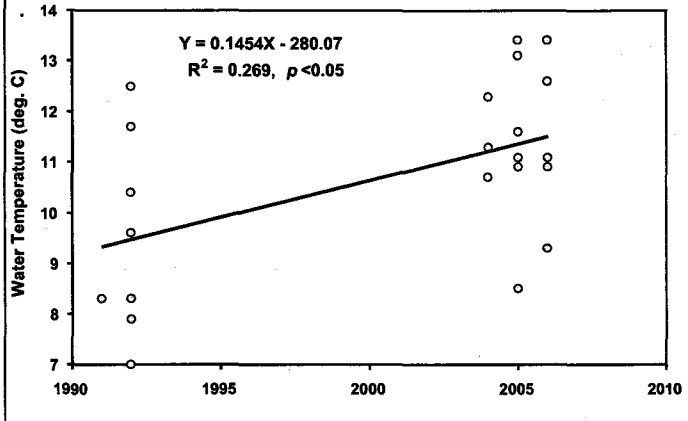

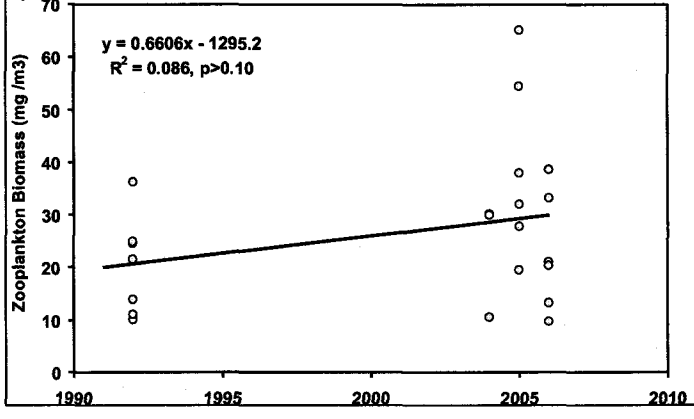

Temporal Trends in Physical and Biological Characteristics

-Water temperatures have increased significantly by about 2°C over the past 10 years

-Zooplankton biomass has not increased significantly during this same period

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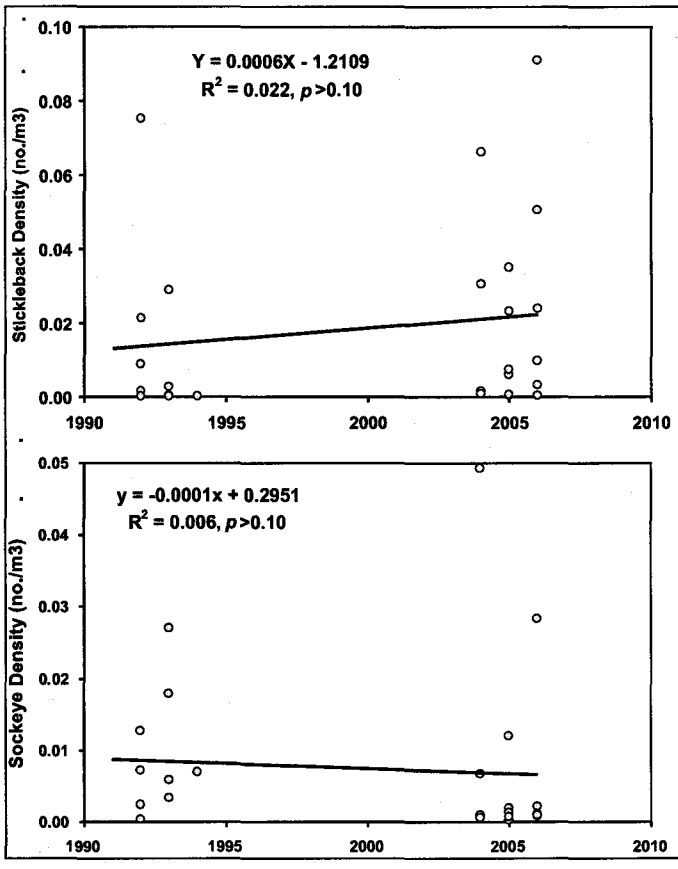


Temporal Trends in Pelagic Fish Densities

-Stickleback densities have increased in some lakes but the overall the trend in not significant

-Sockeye salmon densities have not increased significantly over the past 10 years

Conclusions

- **Freshwater production of sockeye salmon in Larson and Chelatna lakes has declined in recent years compared with historical estimates**
- **Freshwater production of sockeye salmon in Larson, Byers, Hewitt, and Shell lakes has been low in recent years compared with other sockeye stocks**
- **Low sockeye salmon smolt populations emigrating from most lakes in 2007 indicate a poor adult return in 2010**

Conclusions

- Sockeye salmon fry growth is strongly related to sockeye salmon density and weakly related to the density of other pelagic fishes (mostly sticklebacks) in rearing lakes
- Small fall fry sizes in Hewitt and Judd lakes indicate that sockeye salmon densities are near rearing capacity in some years
- Lower egg-fall fry survivals and higher fry growth rates in shallow lakes suggest that predation losses are higher in these habitats

Conclusions

- Water temperatures in rearing lakes have increased significantly by about 2°C over the past 10 years

Kenai River Sonar Studies – Sockeye Salmon

2008 Report to the Alaska Board of Fisheries

RC 4 Tab 9

Suzanne L. Maxwell and April V. Faulkner

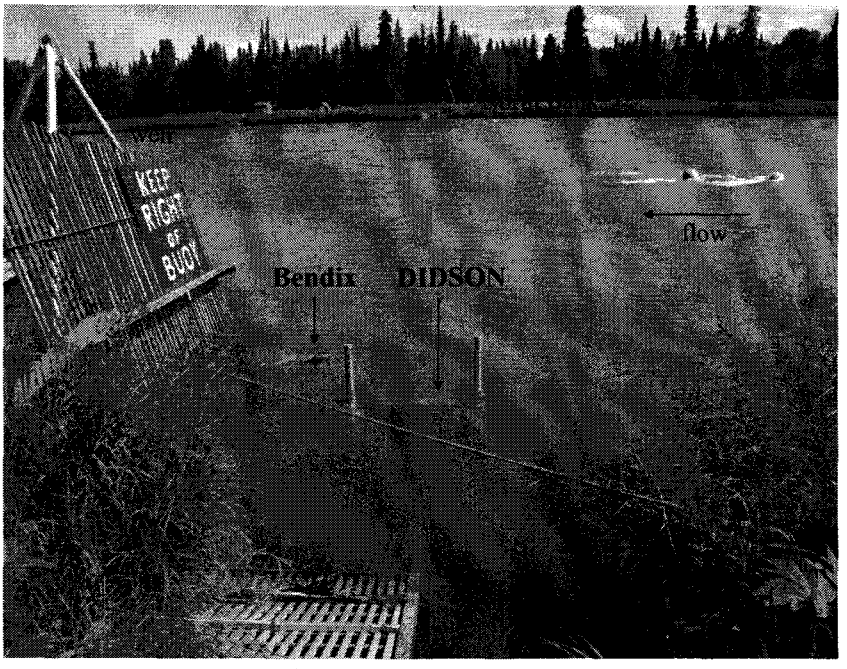
Alaska Department of Fish & Game
Region II Commercial Fisheries Division
Soldotna, Alaska

Two Study Components

- Compare Bendix and DIDSON counts of migrating salmon
- Determine a total variance for the DIDSON estimates

Replacing the Bendix Counter

Sockeye Salmon Sonar Site – RM 19 on the Kenai River



Bendix-DIDSON Comparison

Objectives

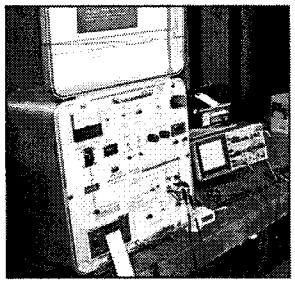
- Determine whether paired Bendix and DIDSON counts were statistically equal
- If different, produce an appropriate adjustment factor
- Correct paired Bendix counts using the adjustment factor and re-analyze
- Correct all historical Bendix counts using the final adjustment factor

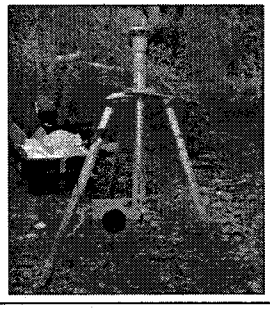
Methods

- Deployed Bendix and DIDSON side-by-side along both banks of the Kenai River
- Aimed the sonar beams along the river bottom where adult sockeye salmon are known to migrate
- Sampled the Bendix counter continuously and the DIDSON 10 min/h/stratum
- Compared the daily counts from each sonar

What is a Bendix Counter?

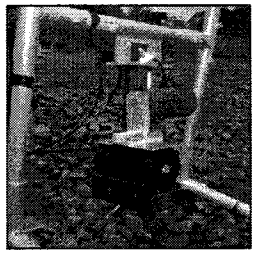
- echo-counting, single beam sonar
- 2 & 4° circular beams

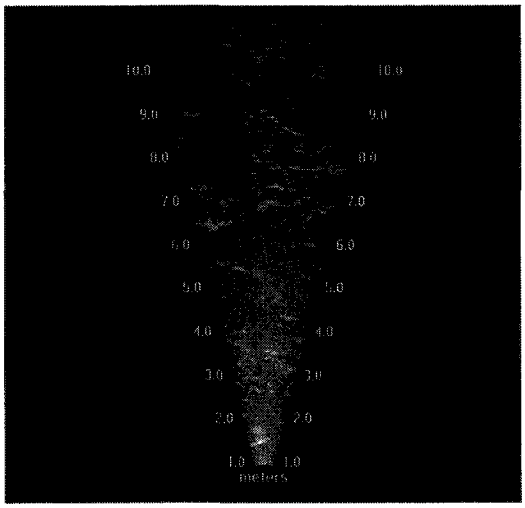




What is a DIDSON?

- Dual-frequency identification sonar
- Multi-beam sonar
- 29° field of view
- 8° or 14° vertical beam





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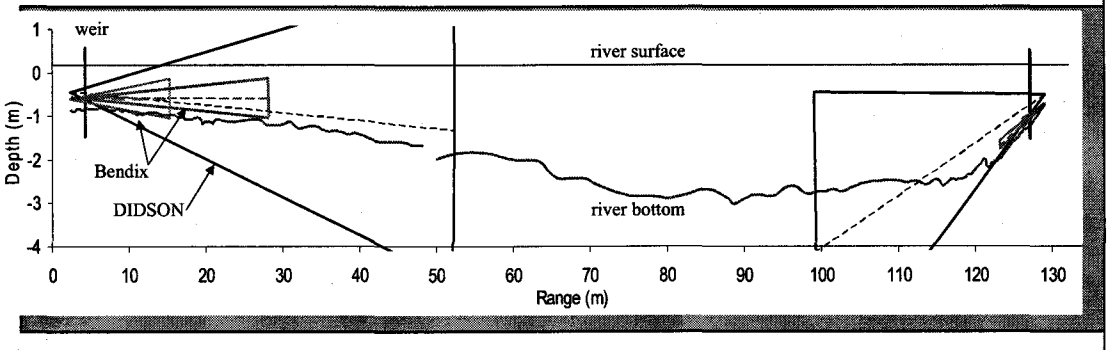
Beam Coverage

Kenai North Bank



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Statistical Methods

Paired data were randomly split into two groups

First dataset - used to determine a multiplier to correct the Bendix counts

- Statistical methods selected that would produce a single multiplier as a correction factor

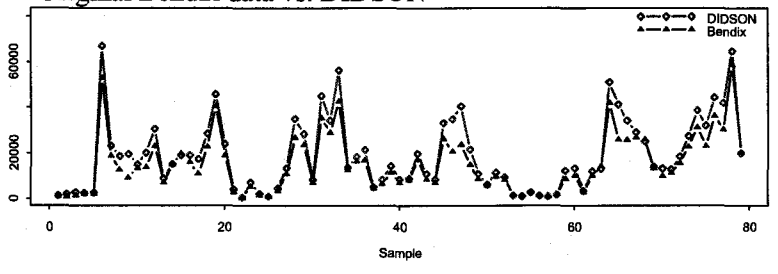
Second dataset – used to test the correction factor

- Corrected Bendix and original DIDSON fish counts were statistically similar
- Bootstrapped 95% Confidence Intervals were calculated for each statistic

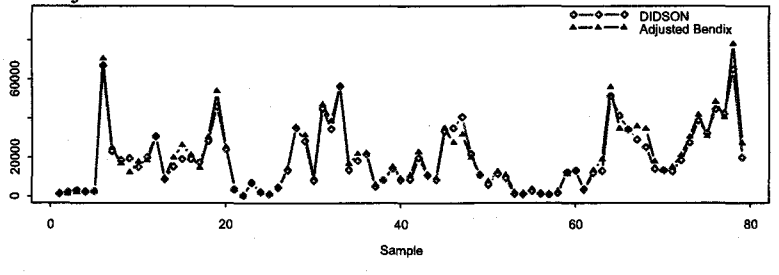
South Bank – Kenai River

Daily fish counts from three field seasons (2004-2006)

Original Bendix data vs. DIDSON



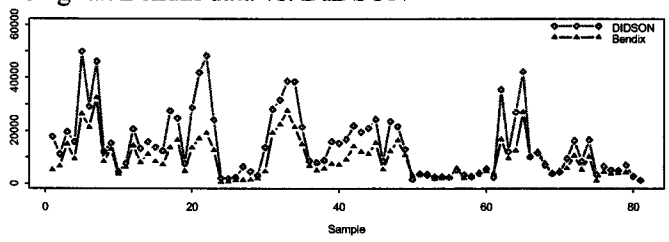
Adjusted Bendix data vs. DIDSON



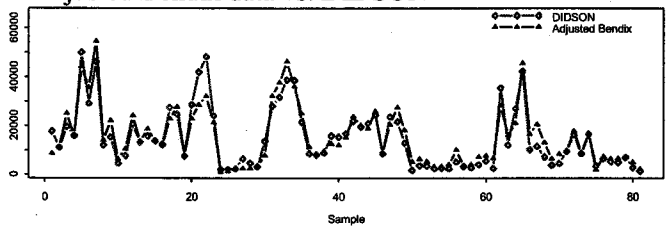
North Bank – Kenai River

Daily fish counts from three field seasons (2005-2007)

Original Bendix data vs. DIDSON

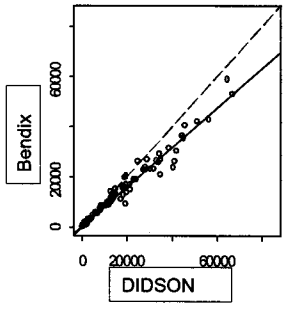


Adjusted Bendix data vs. DIDSON

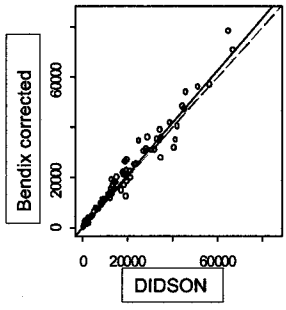


Regression Plots

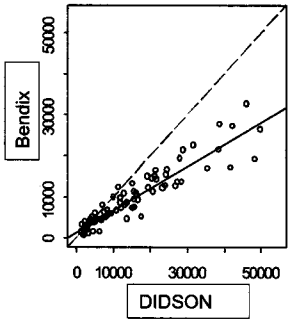
South Bank - Original data



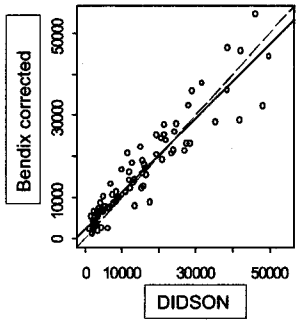
Corrected data



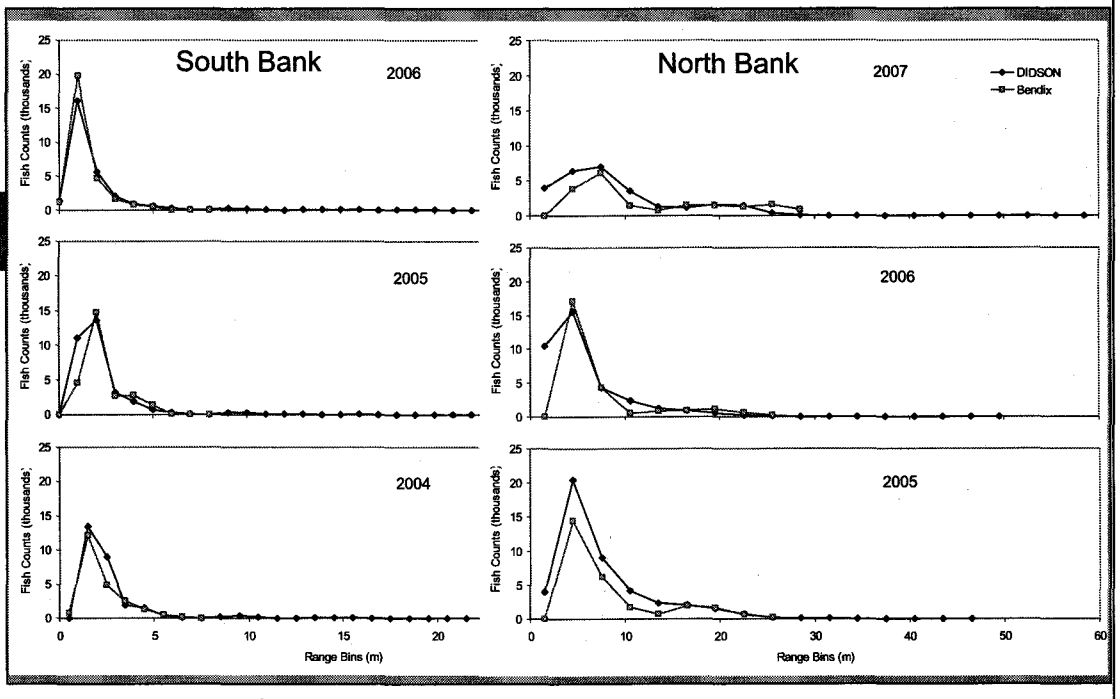
North Bank – Original data



Corrected data



Range Distributions



Bendix and DIDSON Salmon Passage Estimates

River Bank-Yr	Bendix Estimate*	DIDSON Estimate	DIDSON 95% lower CI	DIDSON 95% upper CI
Kenai SB-04	681,466	882,520	864,877	900,163
Kenai SB-05	705,699	917,352	898,205	936,499
Kenai SB-06	1,174,891	1,409,789	1,390,477	1,429,101
Kenai SB-07		557,232	545,493	568,971
Kenai NB-05	538,144	955,979	935,666	976,292
Kenai NB-06	686,674	1,069,180	1,051,224	1,087,136
Kenai NB-07	407,409	578,202	566,290	590,114

* Estimates from paired, unapportioned sonar counts.

Kenai Adjustment Factors

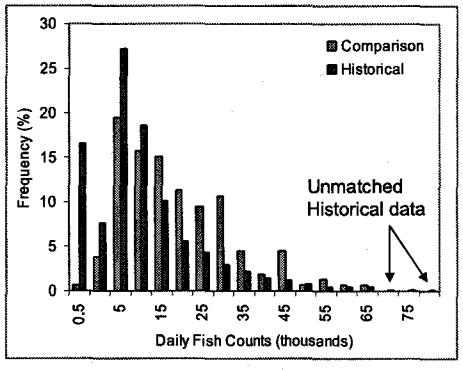
South Bank - 1.33

North Bank - 1.68

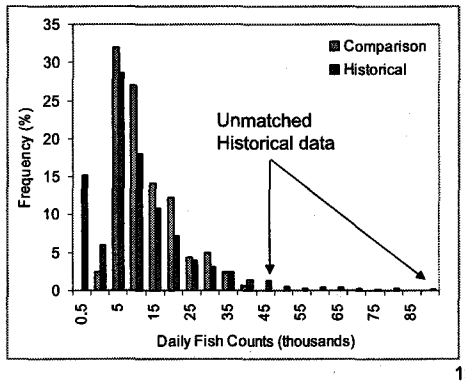
Bendix Historical Data 1980-2006

- Daily count distributions from the Bendix historical and Bendix comparison data were statistically different ($p<0.001$, Kolmogorov-Smirnov goodness of fit test for grouped data)
- Comparison data did not include the highest observed daily counts

South Bank



North Bank

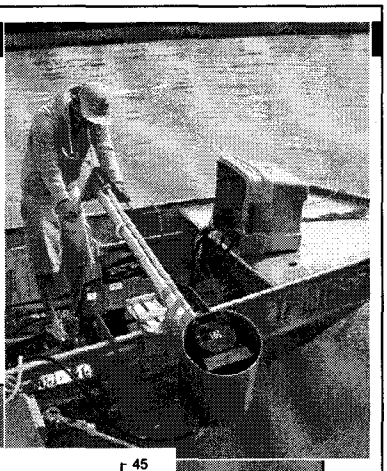


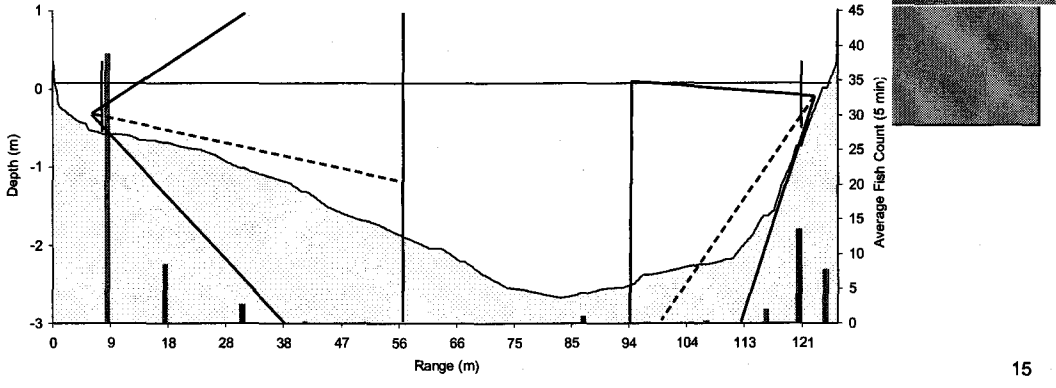
Can a variance be determined for the DIDSON estimates?

1. Do 10 min/h DIDSON counts accurately represent hourly fish passage?
   Subsampling – V5 variance estimator
2. Are fish passing beyond the range of the shore-based sonars?
   Cross-river fish distribution – mobile DIDSON
3. Are fish passing over or under the sonar beam?
   Vertical fish distribution – DIDSON positioned vertically
4. Are we detecting the fish that pass through the sonar beam?
   Target detection within sonar beam – target work
5. Are there biases between the observers' manual fish counts?
   Observer counting errors – multiple observer counts
6. What are the errors in the species apportionment?
   Species apportionment – fishwheels

Cross-River Fish Distribution

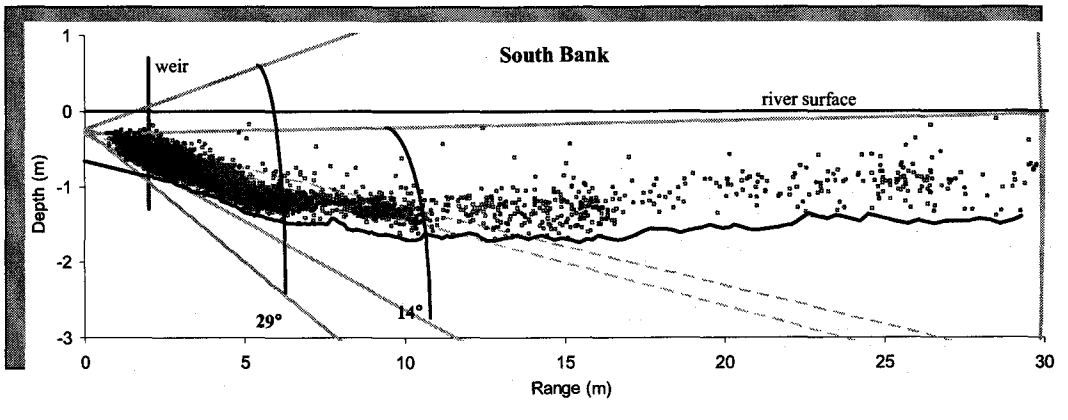
- 13 stations, 22 transects across 11 days
- Fish mostly nearshore
- 1.8 % of fish observed offshore of the transducer's range
- Past netting studies corroborate few fish mid-river





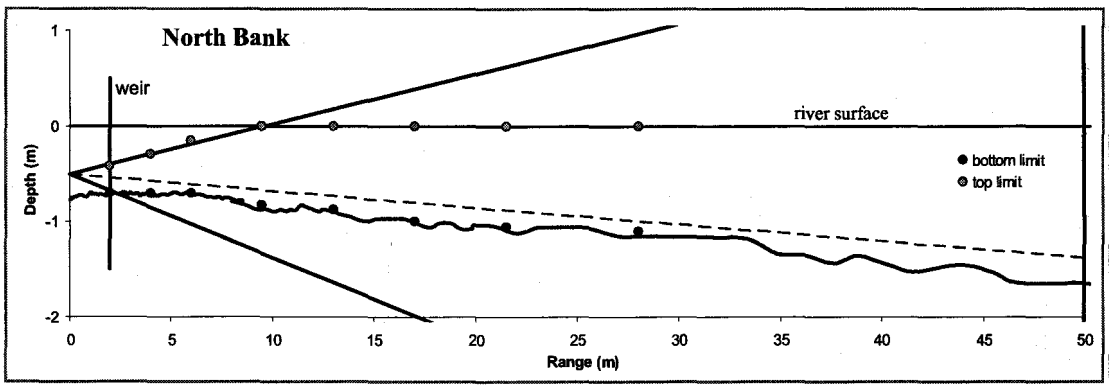
Vertical Fish Distribution

- Deployed DIDSON vertically to record the position of fish in the water column (2007, south bank only)
- Four samples/day randomly selected to process, a total of 9,119 fish
- 95.3% of fish within 10 m of transducer
- 99.5% of fish within the 14° horizontal beam



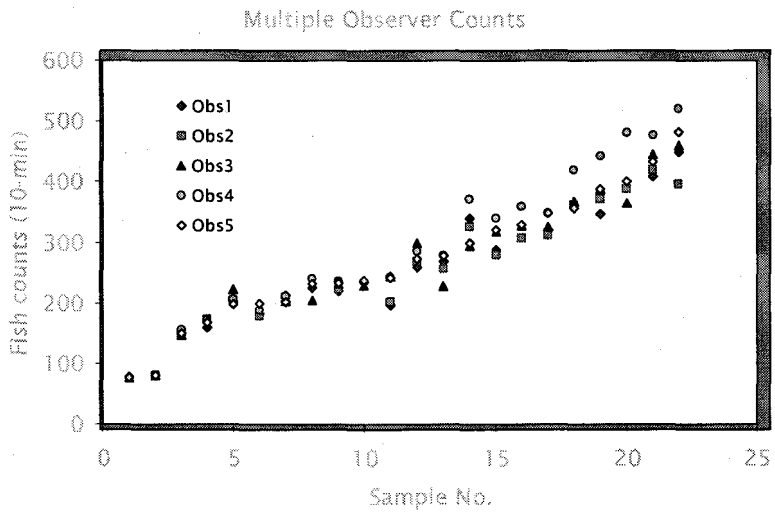
Target Detection within Sonar Beam

- Detected a 4 in stainless steel sphere along the river bottom at all ranges tested and up to the surface starting at 10 m (north bank)



Observer Counting Errors

- 3-5 observers, 22 samples, Average Percent Error (APE) of 4.40%



Species Apportionment - Fishwheel

Unknowns

- Catchability rates of different species?
- Effect of fish density on cross-river distribution of fish species?
- Fishwheel efficiency?

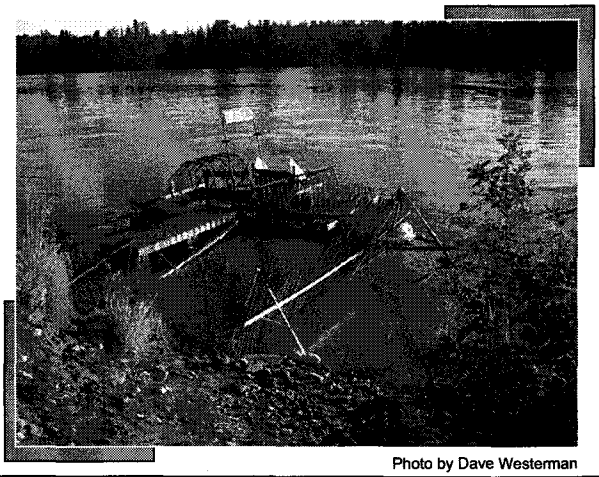


Photo by Dave Westerman

Possible studies

- DIDSON cross-river fish distribution at fishwheel site
- Large lens DIDSON to determine fish size by range (more testing needed to determine accuracy)
- Acoustic tags on multiple species – learn where in the river fish of different species migrate

Tentative Sonar Variance – 2007 Kenai River

1. Subsampling Errors	+/- 2.1%
2. Outside range	+ 1.8%
3. Over top of beam	+ 0.5%
4. Missed within beam	0%
5. Observer error	+/- 2.2%
6. Species Apportionment	??
TOTAL known error:	- 4.3% and + 6.6%

Conclusions

- DIDSON estimates of salmon passage larger than Bendix
  - South bank 1.33x more fish and north bank 1.68x more
- Adjusted Bendix counts similar to DIDSON counts
  - A single multiplication factor effectively removed the bias
- Re-evaluation of escapement goals needed after transition
- Sonar variance studies provide strong evidence that DIDSON estimates include the majority of salmon passing the sonar site
- More data needed to determine a total variance
- Error in species apportionment needs to be addressed

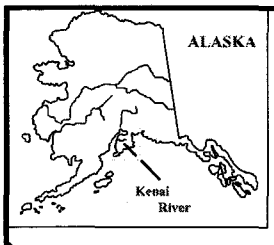
Inriver Abundance and Spawner Distribution of Kenai River Sockeye Salmon

Report to the Alaska Board of Fisheries

By

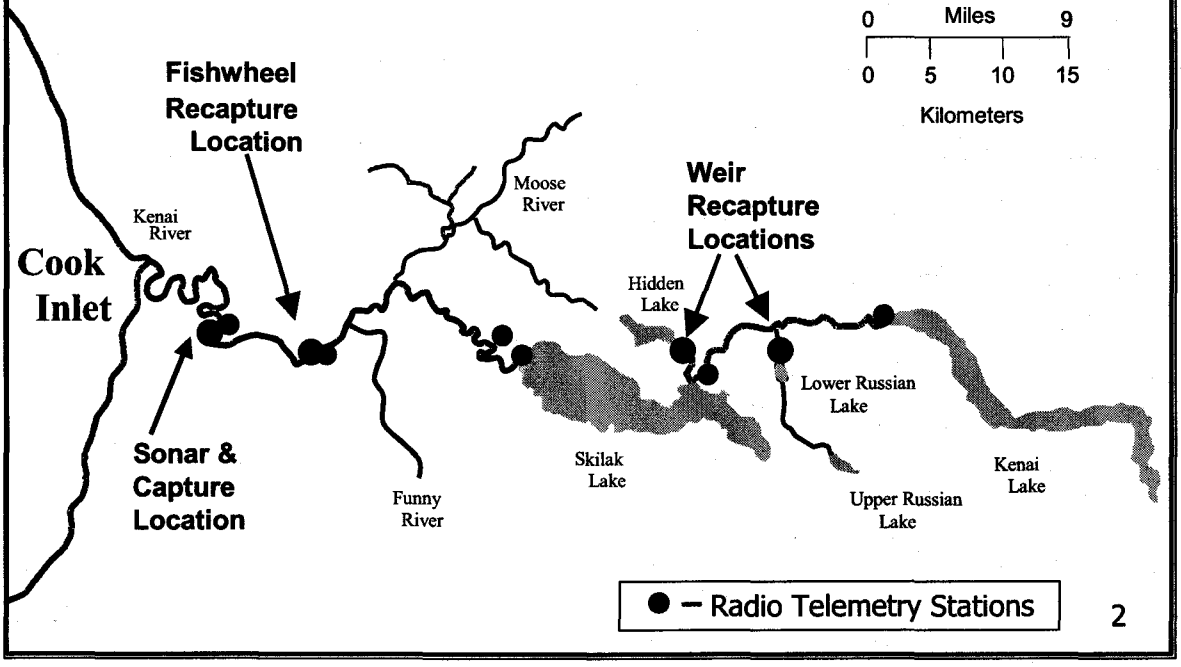
Mark Willette,Tim McKinley, Scott Raborn, and Robert Decino, Alaska Dept. of Fish and Game

RC4 Tab 10

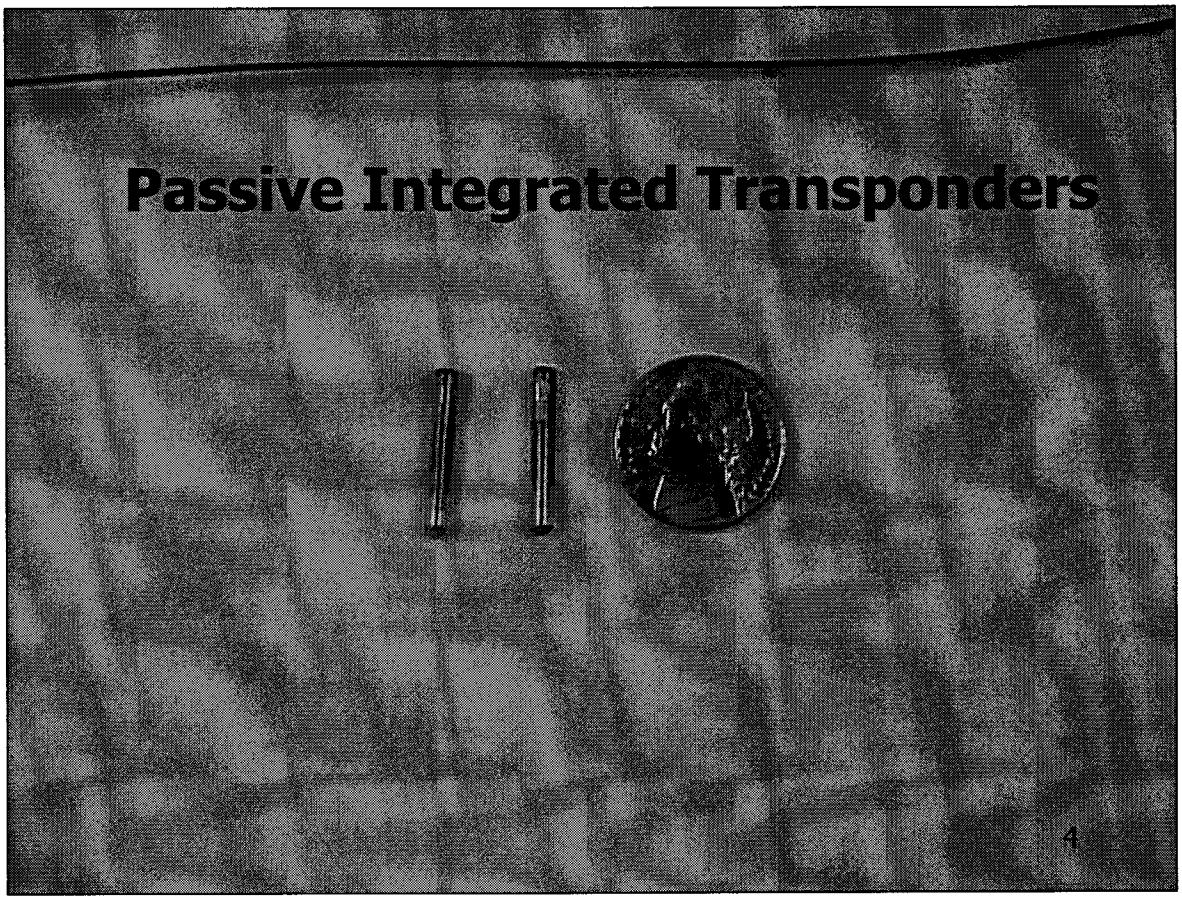


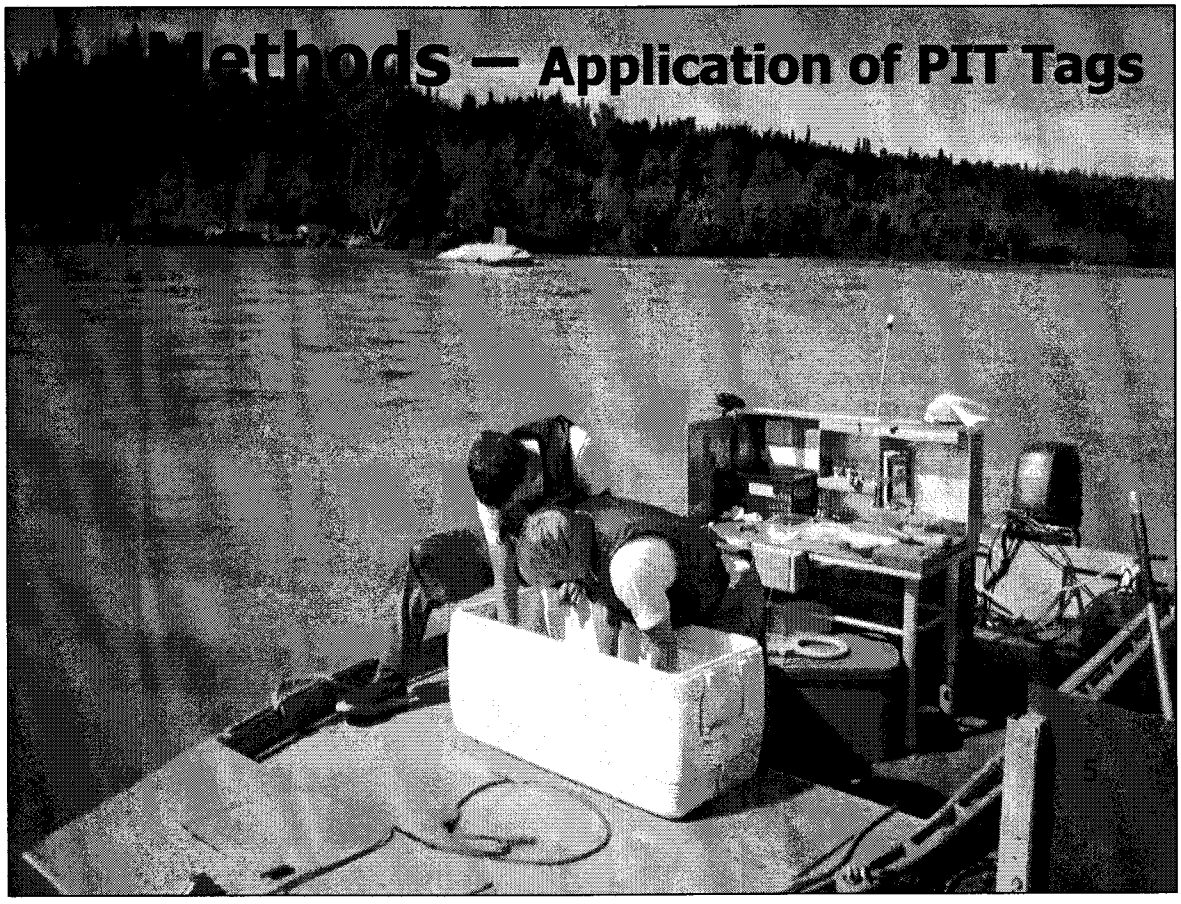
Objectives:

1. **Estimate inriver abundance of sockeye salmon in the Kenai river using mark-recapture**
2. **Determine spawner distribution using radio tags**



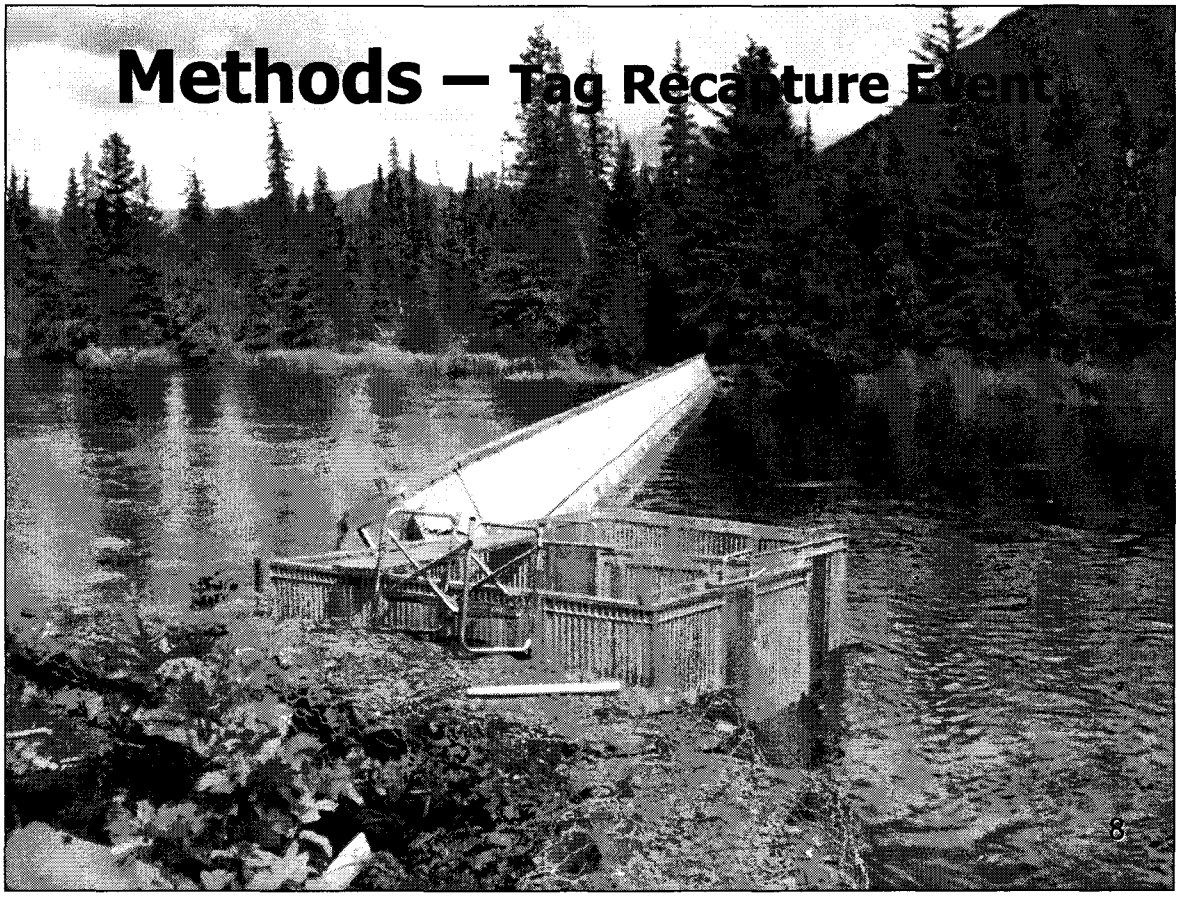

Methods – Tagging at RM19 Sonar Site
3

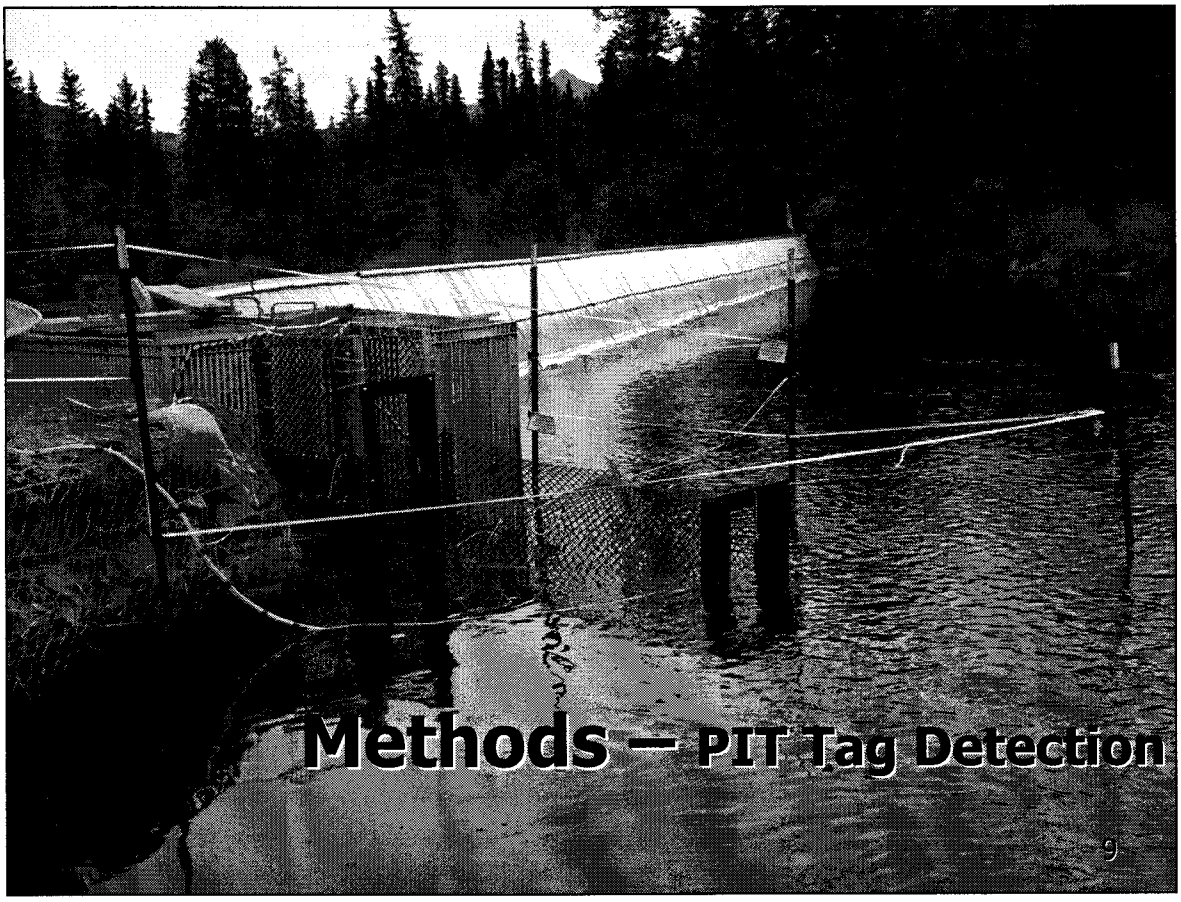

Passive Integrated Transponders
4

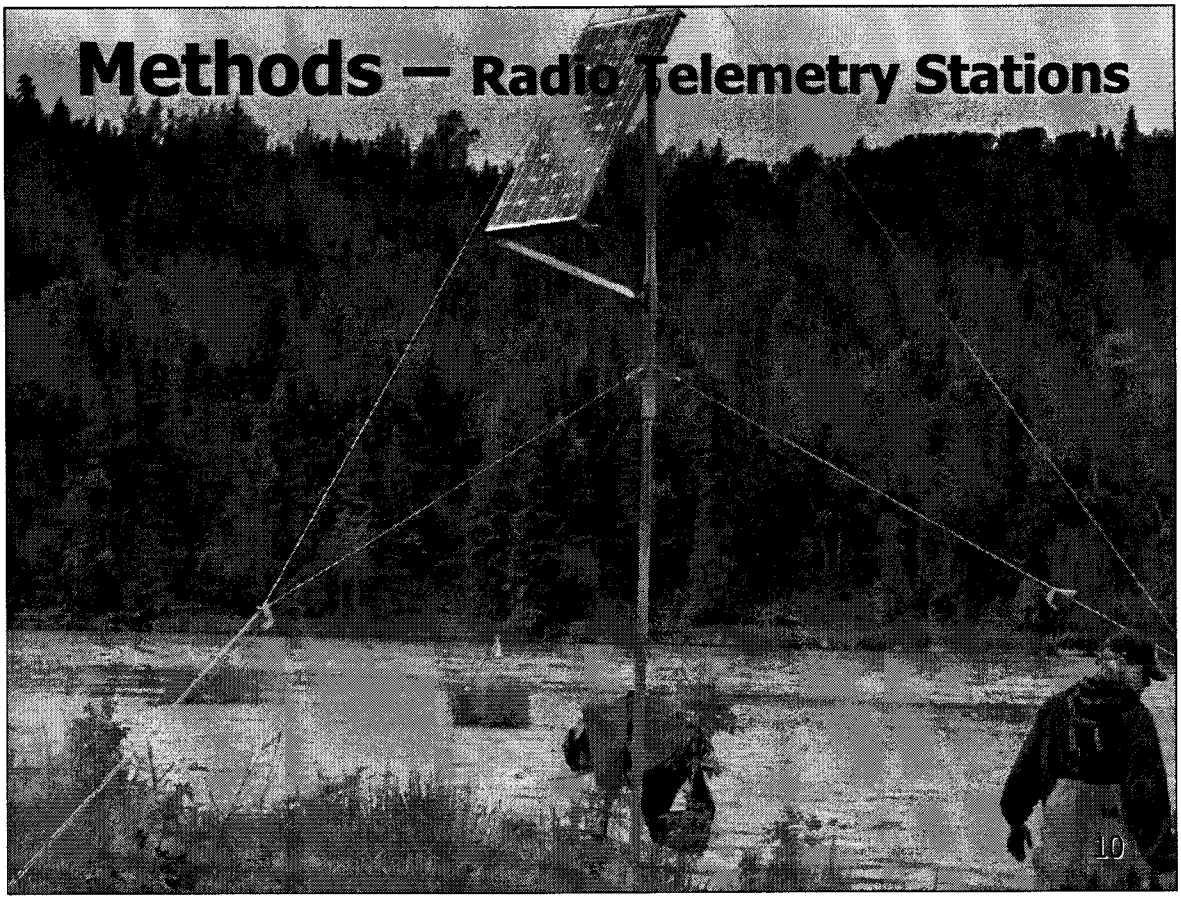

Methods – Application of PIT Tags

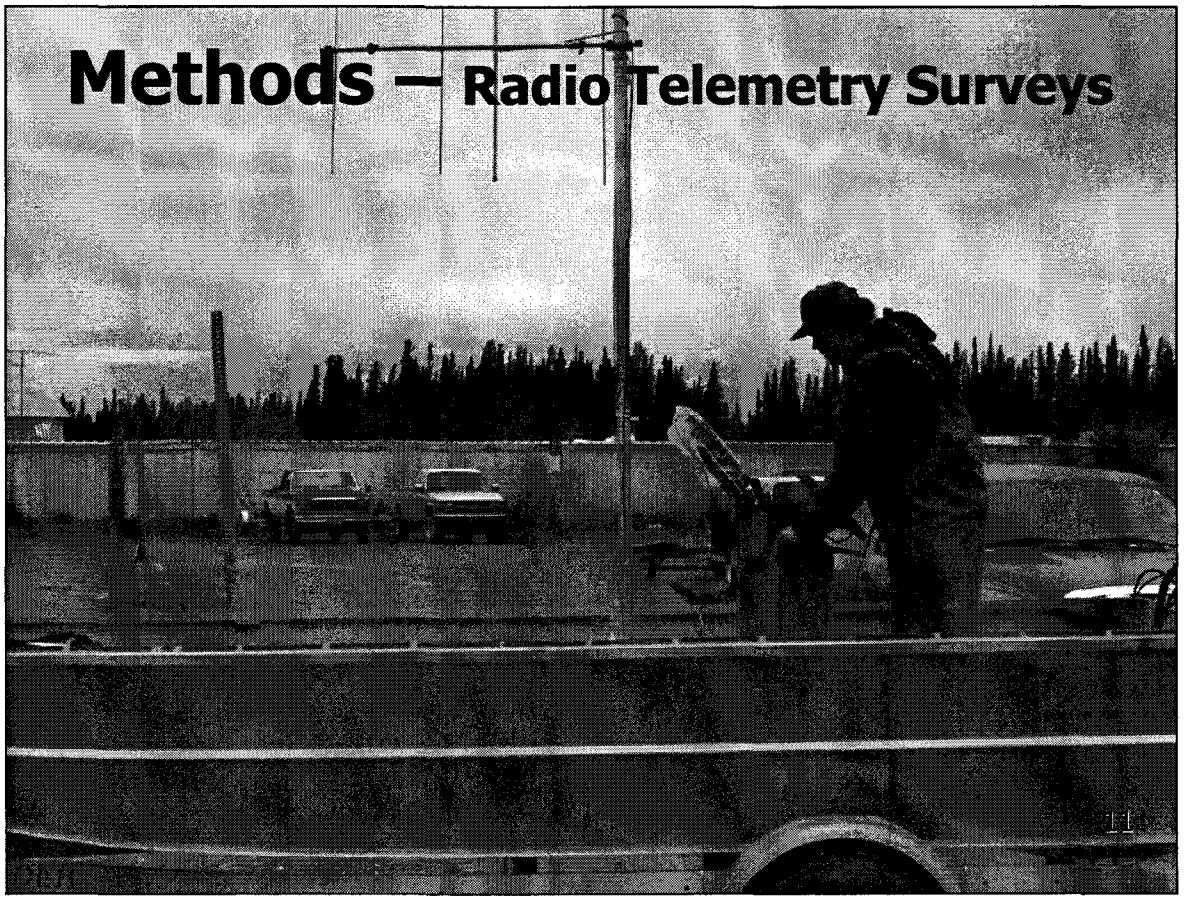

Methods – Logging PIT Tag Data


Methods – Sam
7


Methods – Tag Recapture Event
8


Methods – PIT Tag Detection
9


Methods – Radio Telemetry Stations
10

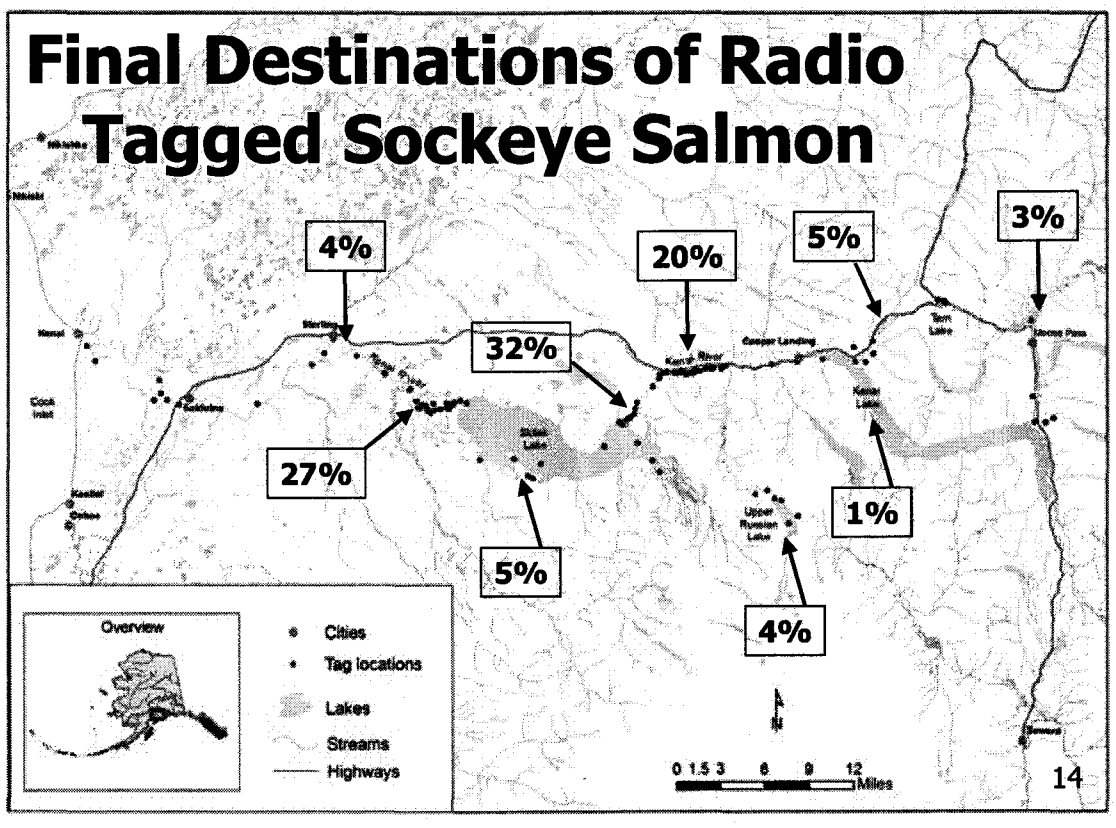


Tagging and Recaptures

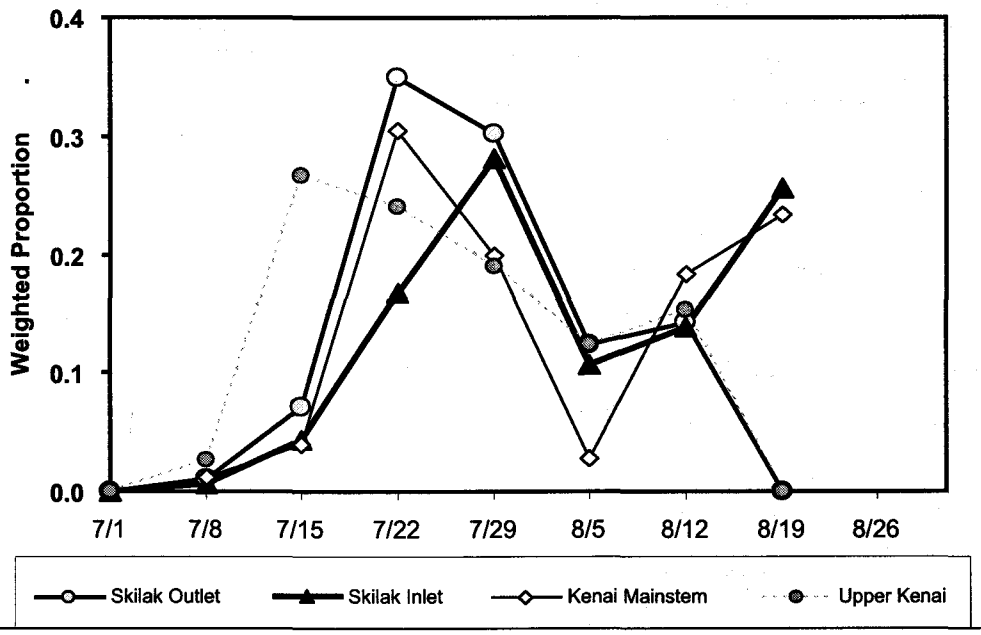
- Applied 6,901 PIT tags July 2 – Aug. 24
- Applied 215 radio tags
- Recaptured 440 PIT tags at RM28 fish wheels, and the Hidden and Russian lake weirs
- Determined the fate of all radio tagged fish

Tests of Assumptions

- Survival of radio tagged fish to RM 28 fish wheels - 93%
- PIT tag retention – 100%
- PIT tag detection at weirs exceeded threshold on 92% of weir days



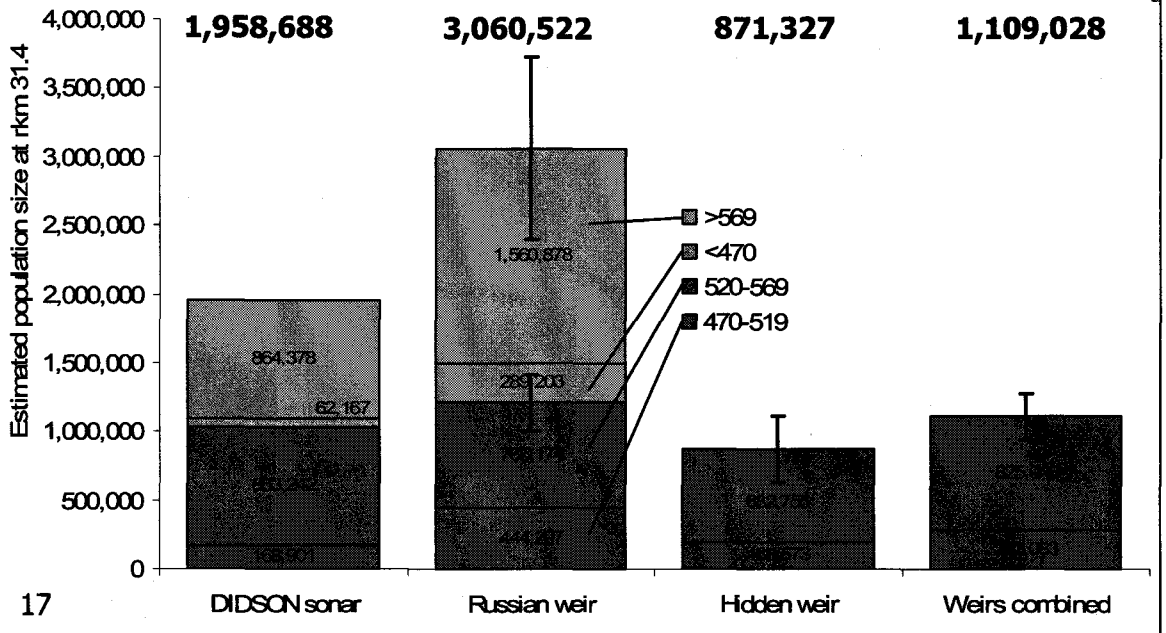
Run Timing of Sockeye Salmon Past Kenai Sonar Site at RM 19



Marked Fractions at Recapture Sites

Recapture Site	Length Class	Number Tags Applied	Number Scanned	Number Tags Detected	Marked Fraction
Russian River	<470	245	18809	15	0.0008
	470-519	630	23939	33	0.0014
	520-569	3144	22657	77	0.0034
	>569	2434	20519	31	0.0015
	Total	6453	85925	156	0.0018
Hidden Creek	470-519	630	26018	112	0.0043
	520-569	3144	10120	73	0.0072
	Total	3774	36138	185	0.0051
RM28 Fishwheels	<540	1717	19924	22	0.0011
	540-589	3789	27971	57	0.0020
	>589	946	14068	10	0.0007
	Total	6453	61963	89	0.0014

Sockeye Salmon Population Estimates



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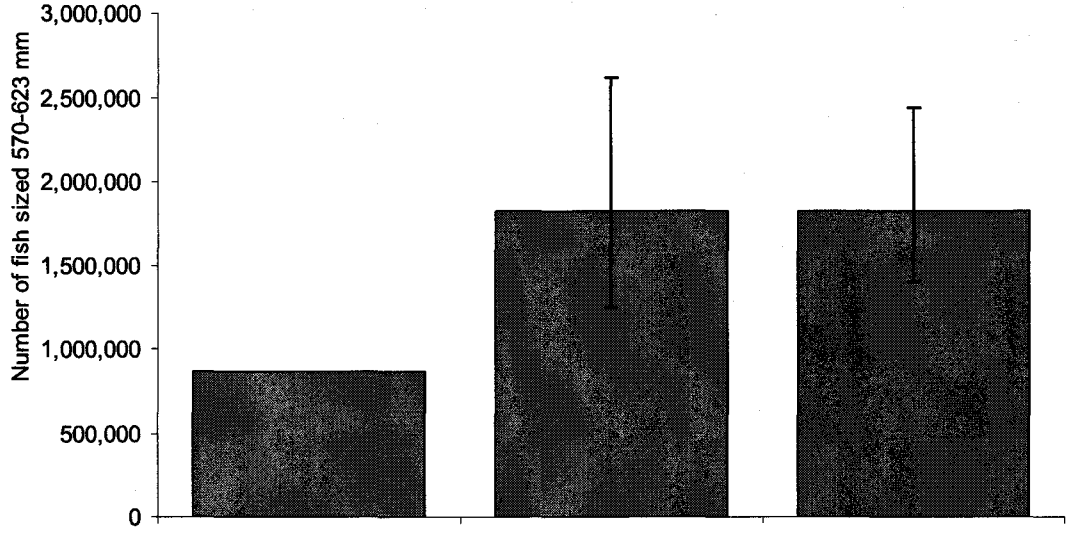
Uncertainty in Population Estimates from Russian River Weir



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Conclusions

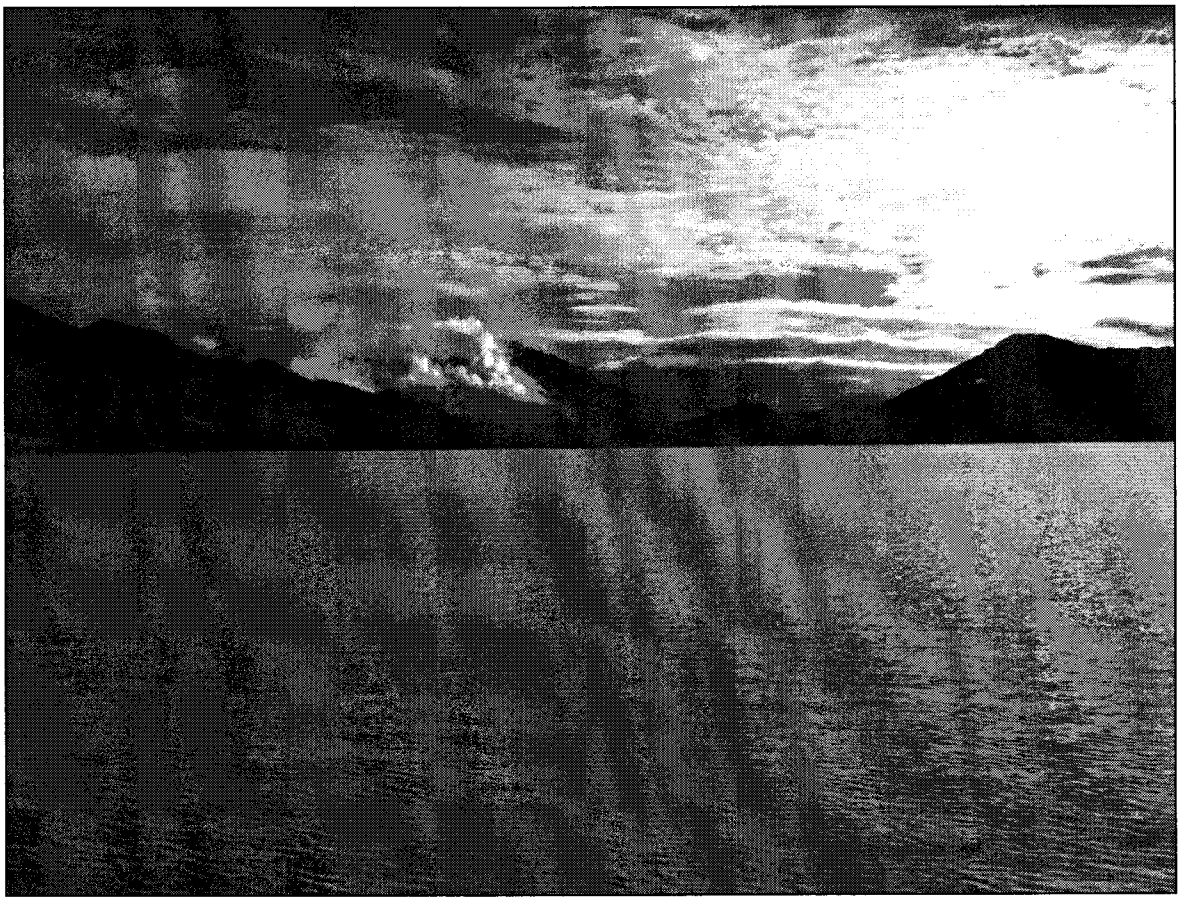
1. The mainstem Kenai River was the final destination for 79% of radio-tagged sockeye salmon.

2. The run timing of radio-tagged sockeye salmon migrating to the upper Kenai River watershed was the earliest, while the run timing of those migrating to the inlet of Skilak Lake was the latest.

Conclusions

3. The Russian River weir mark-recapture population estimate of sockeye salmon abundance passing RM 19 was 3,060,522, while the DIDSON sonar abundance estimate was 1,958,688.

4. The mark-recapture and sonar estimates only differed for the smallest and largest length classes.



Post-season Stock Composition Analysis of Upper Cook Inlet Sockeye Salmon Harvest, 2005-2007

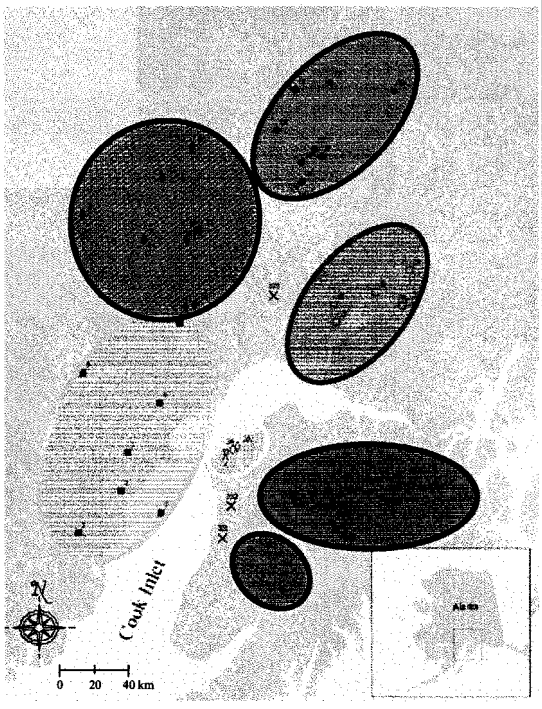
Christopher Habicht,
William D. Templin,
T. Mark Willette,
Lowell F. Fair,
Scott W. Raborn,
and
Lisa W. Seeb

Oral Report:
Tab 11
Written Report:
Tab 7

Genetics analyses

- Baseline development
- Baseline evaluation
  - Simulations
  - Proof tests
  - Fish wheel samples
- Mixed stock analysis
  - Offshore test fishery sampling
  - Drift gillnet
  - Set gillnet

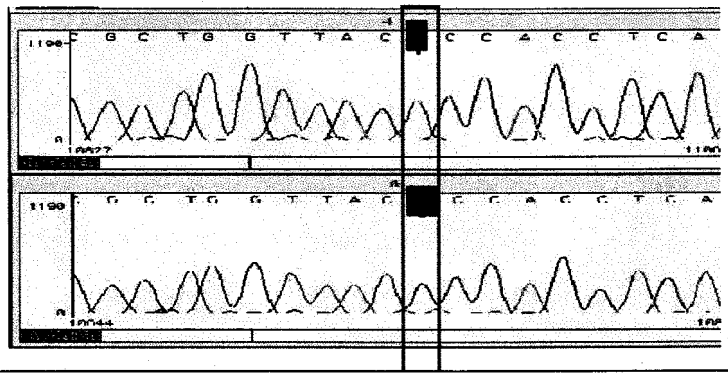
Baseline collections – 7 reporting groups



- 1992 to 2006
- 68 collections
- 62 locations

Genetic markers

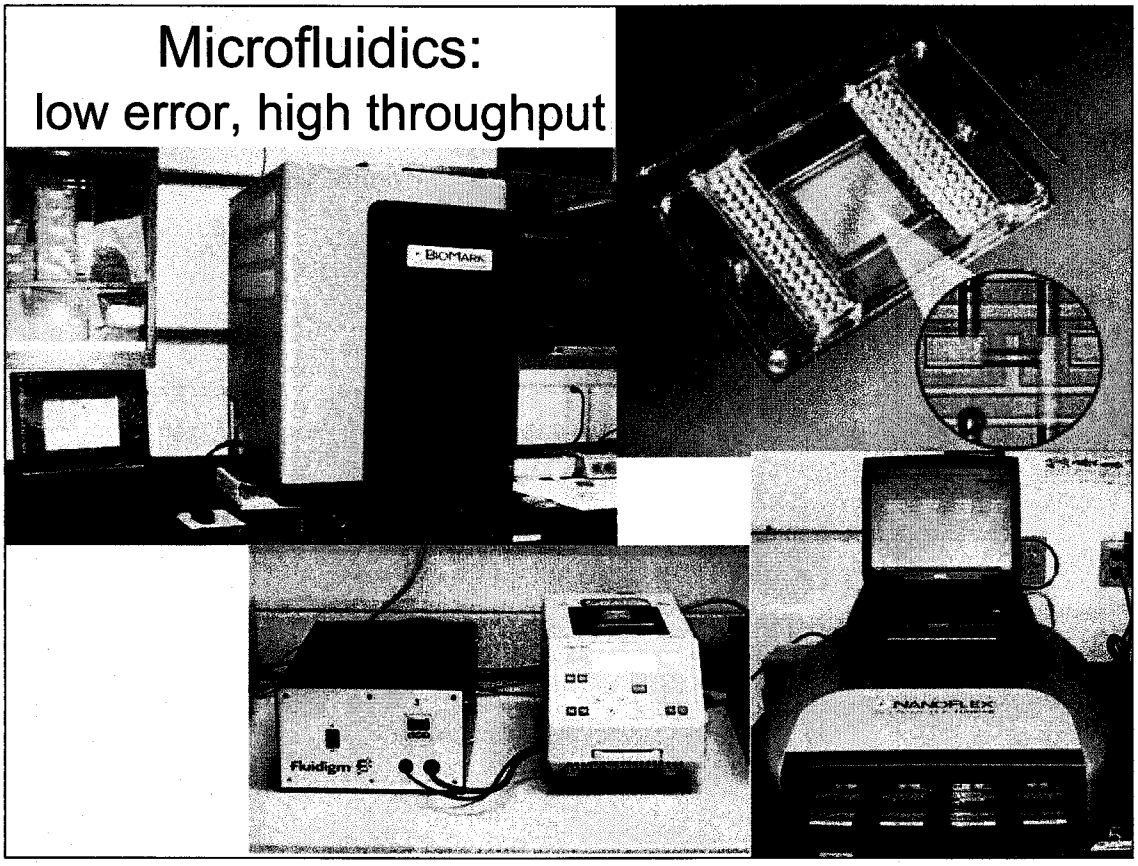
- Single Nucleotide Polymorphisms (SNPs)
  - Two alleles
  - Rapid assay
- Screen 45 markers



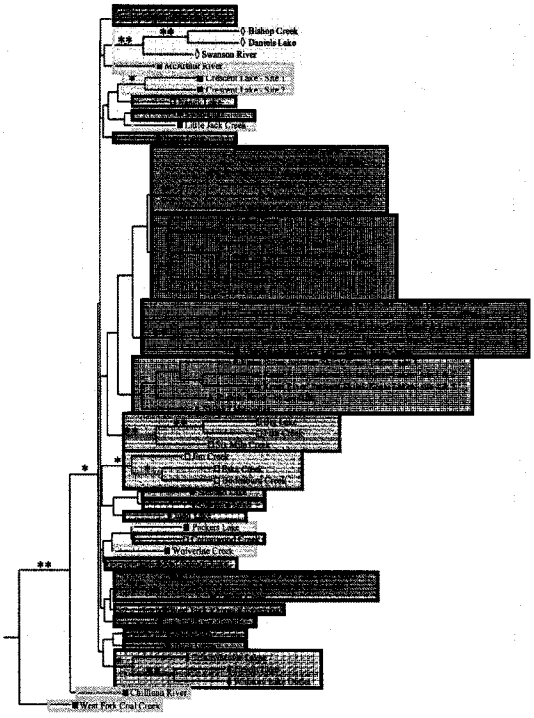
T

C

Microfluidics:
low error, high throughput

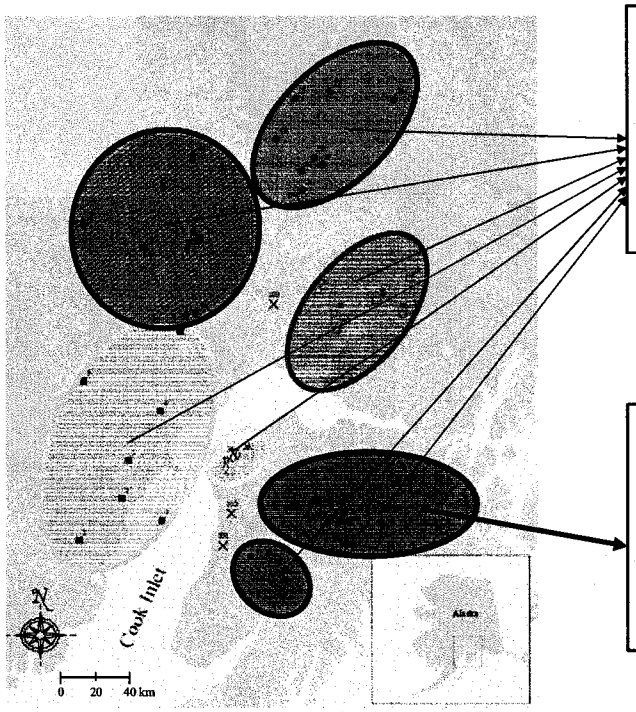


N-J tree on Nei distances



- Kasilof
- Kenai
- Northeast
- Knik
- Susitna
- Yentna
- West

Proof tests - methods



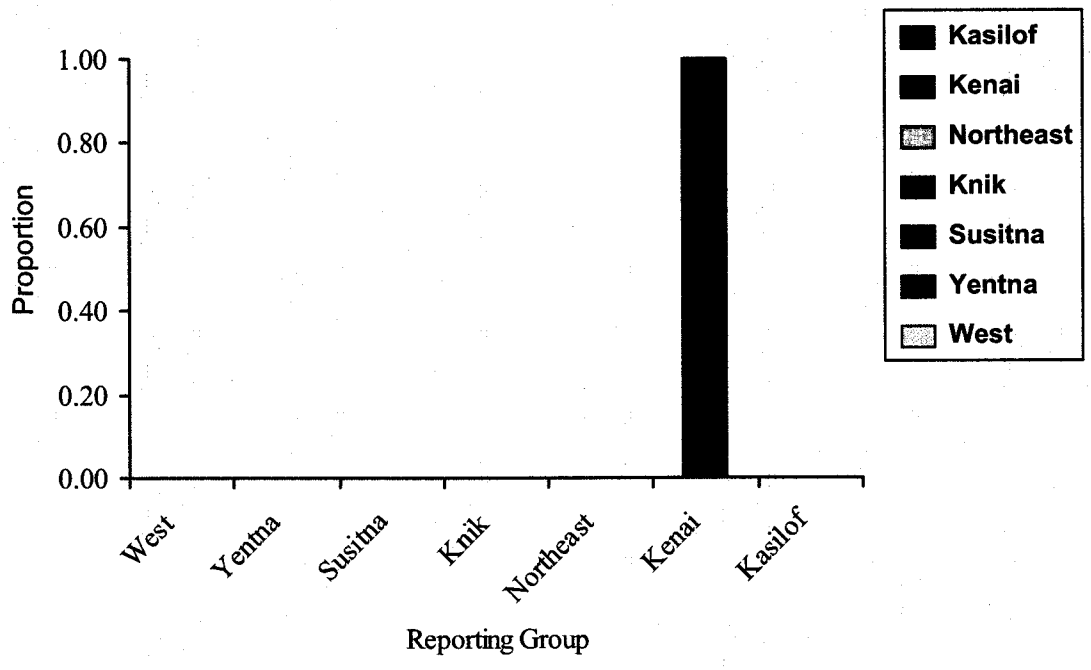
Baseline:

Use all the baseline except for 200 fish from one reporting group.

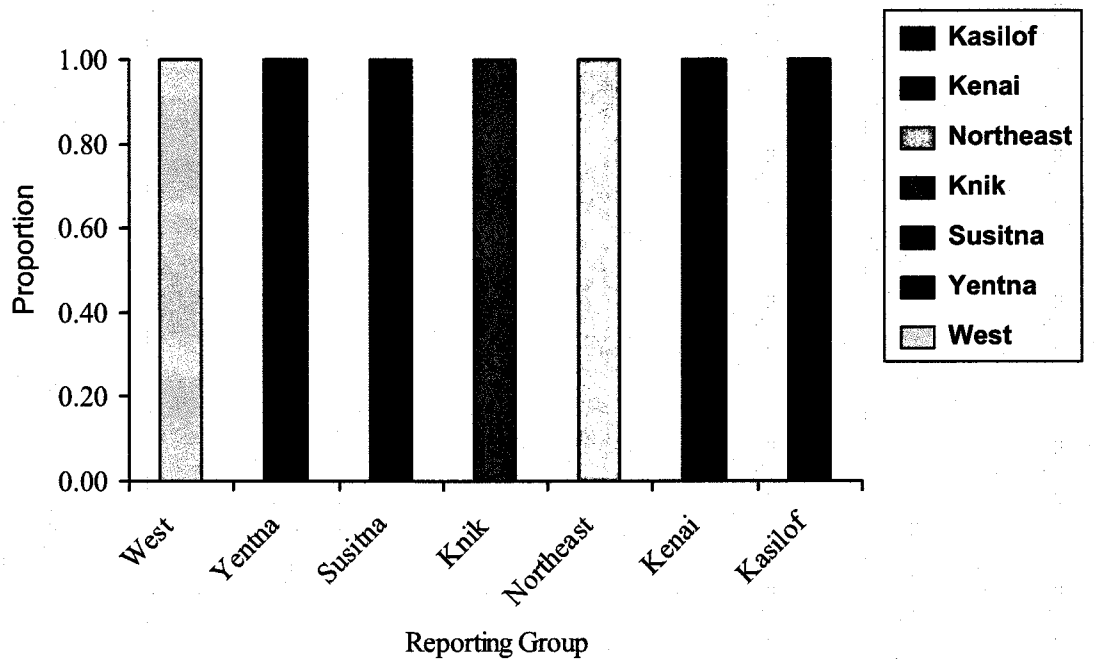
Mixture:

Use the 200 fish taken out of the baseline.

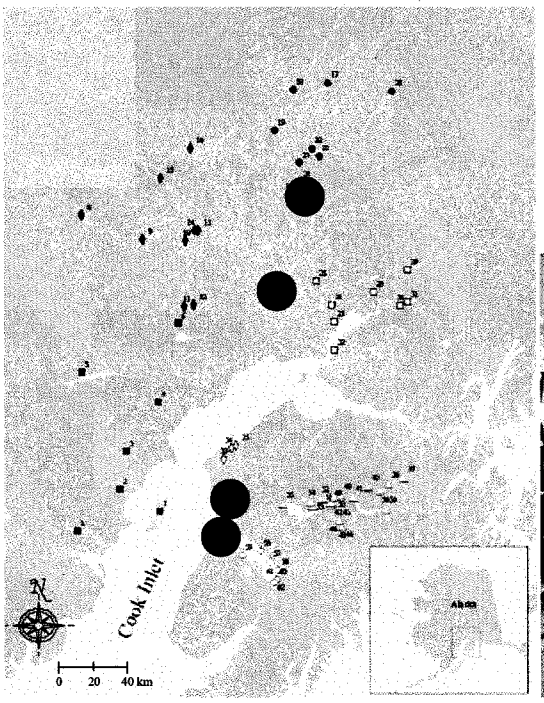
Proof test – Kenai reporting group



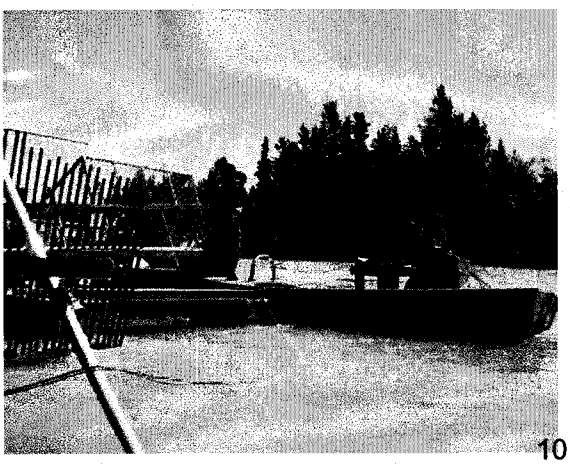
Proof tests – all reporting groups good



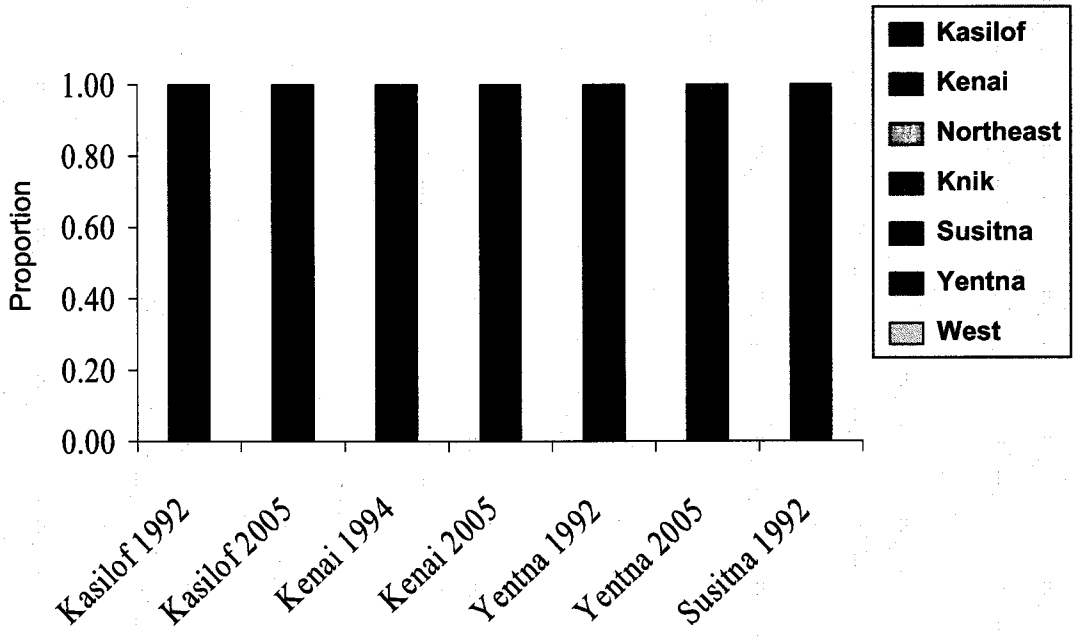
Fish wheel samples - methods



- 1992 and 2005
- All four major drainages
- 190 fish per sample

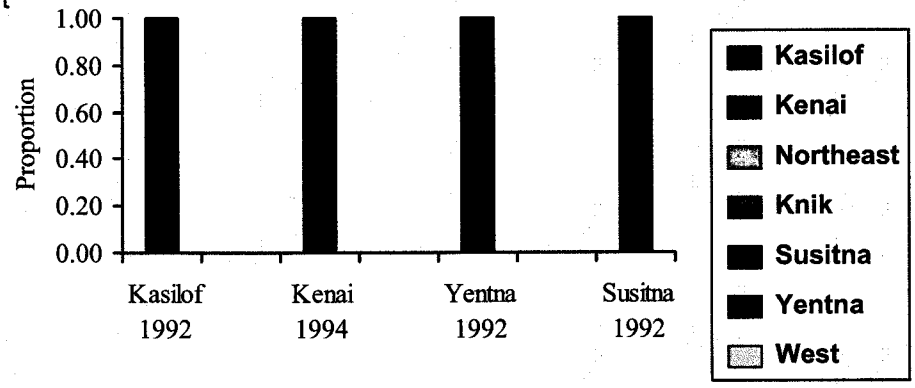


Fish wheel results – baseline near-saturation



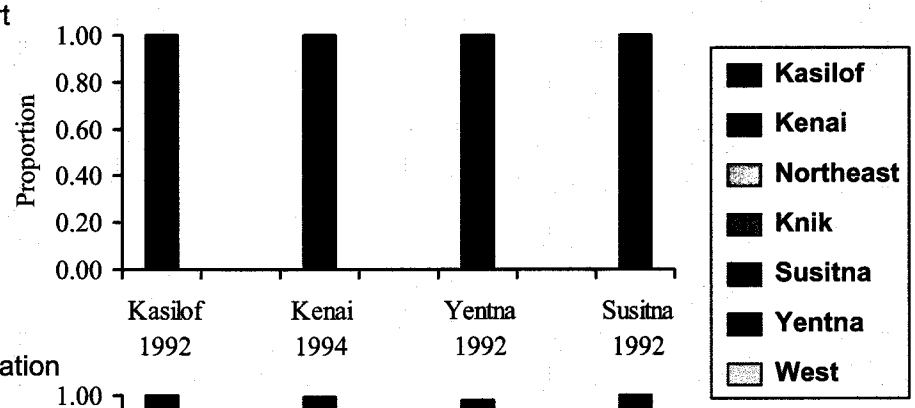
Fish wheel results – 1990's samples

2008 report

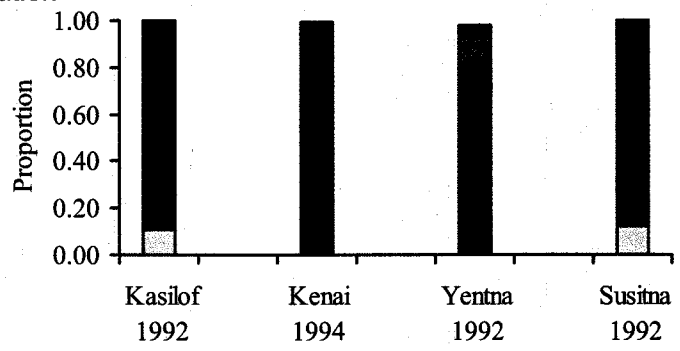


Fish wheel results – New methods, much better

2008 report



2000 publication



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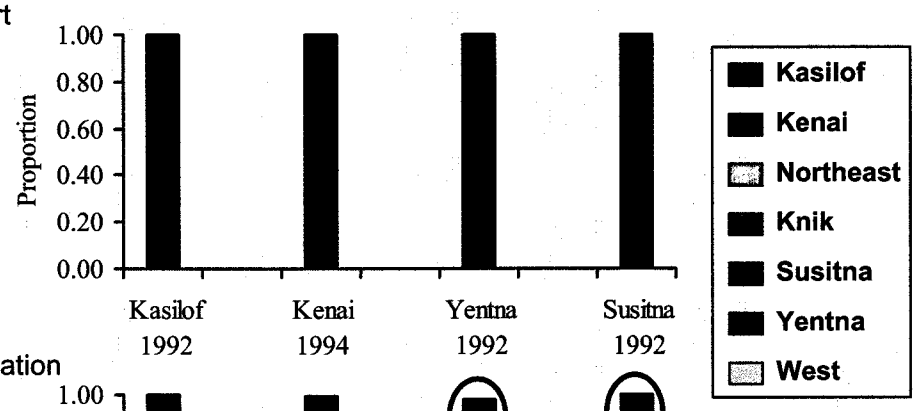
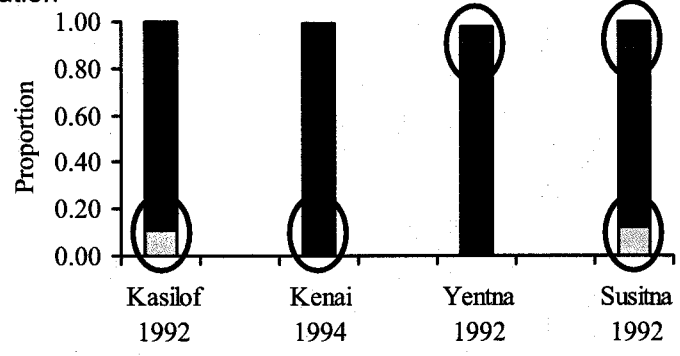
Fish wheel results – New methods, much better

2008 report



2000 publication



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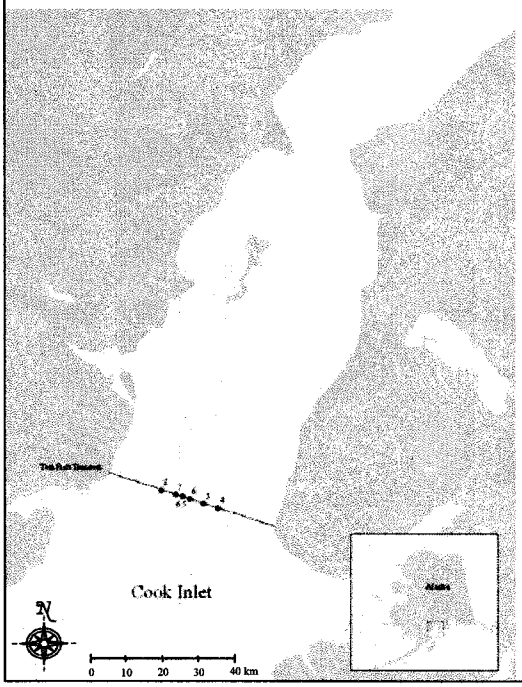
Two sources of statistical error

- Genetic error
  - Uncertainty due to use of genetics as a mark.
  - Proof tests and fish wheels indicate these are small.
- Sampling error
  - Uncertainty due to sampling of the harvest.
  - Estimate +- 5% of the true value with sample size of 400 fish, 90% of the time (+- 7% with 200 fish).
  - Samples need to represent the harvest.

Sampling mixtures

Offshore test fishery - methods



- 2006 and 2007
- Up to 30 fish from each station
- Sample not weighted by catch

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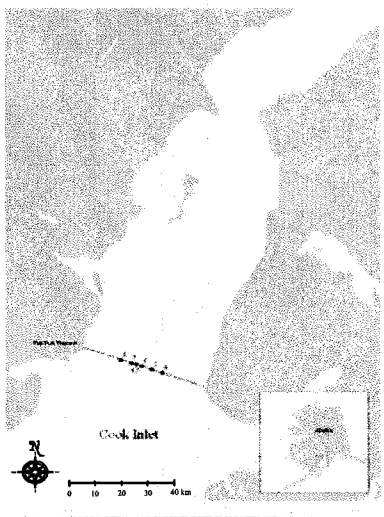
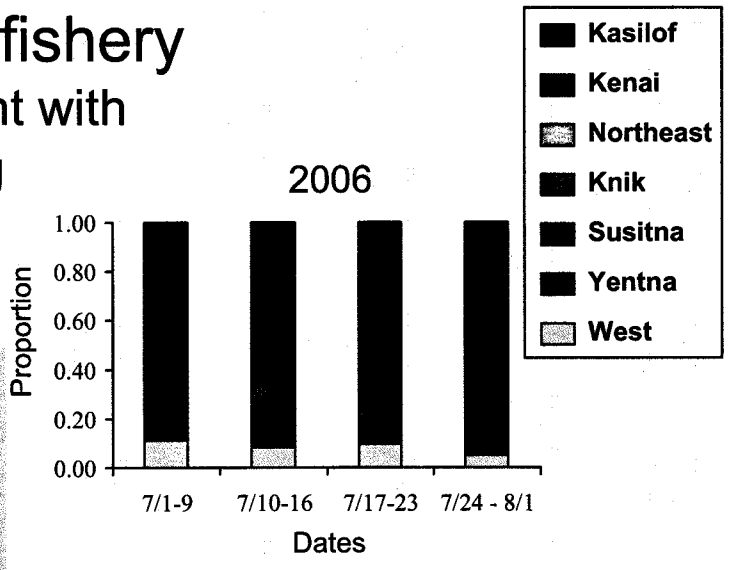
Offshore test fishery

Pattern consistent with known run-timing





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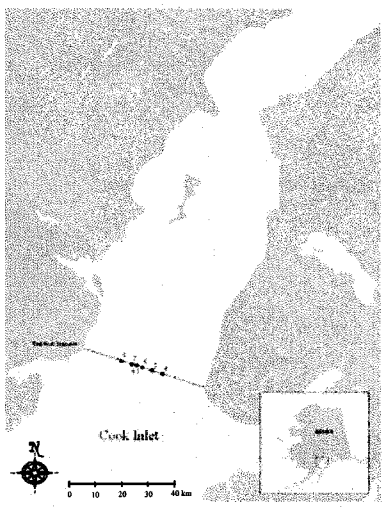
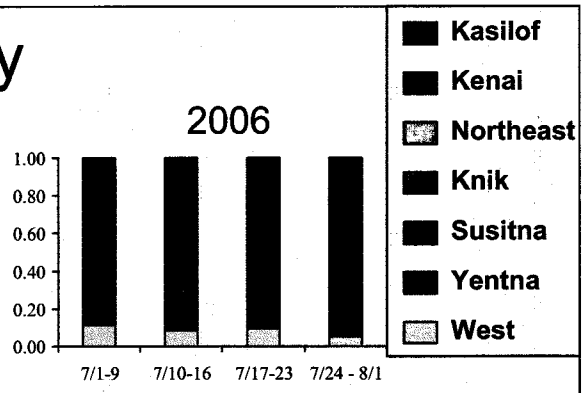
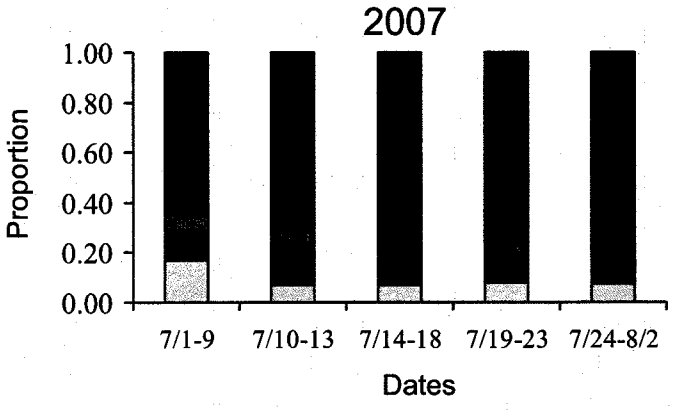
Offshore test fishery

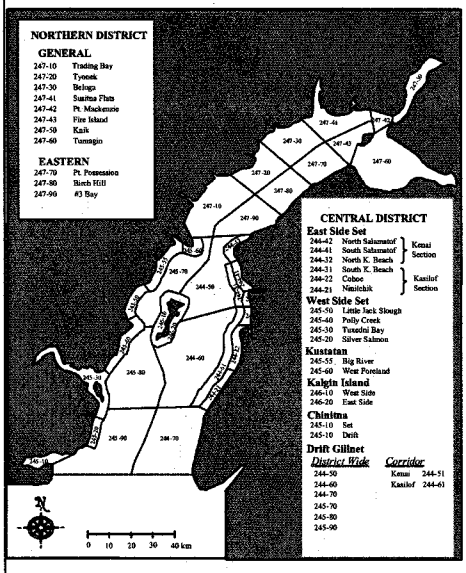
Pattern consistent with known run-timing





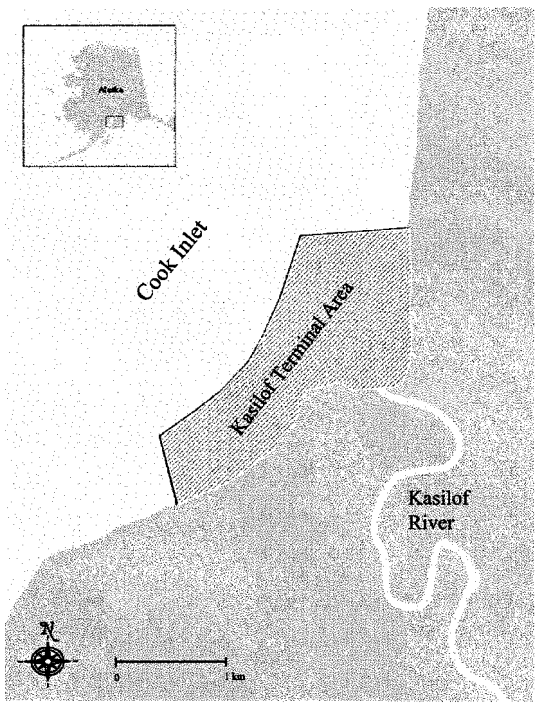


Sampling Fishery Mixtures - methods



- 2005, 2006, and 2007
- Samples collected
  - 230 collections
  - 39,000+ fish sampled
  - Throughout the season
  - Northern and Central Districts
- Analyzed only selected samples
  - Central District Drift
  - East Side Subdistrict Set
  - 35 mixtures analyzed
  - 12,300+ fish analyzed

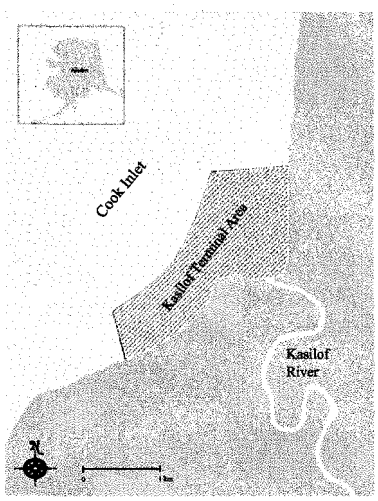
Kasilof Terminal Area - methods

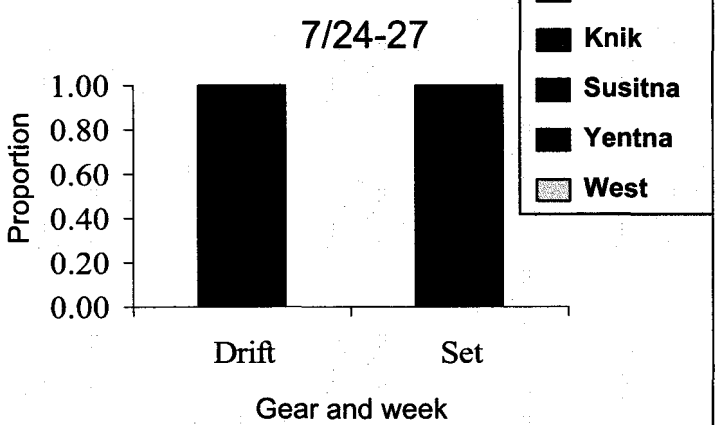


- Only 2006
- Drift gillnet
- Set gillnet
- Two periods sampled
- One period analyzed

Kasilof Terminal Area

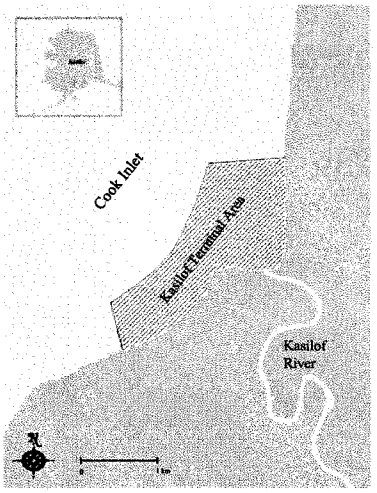
Mostly Kasilof fish

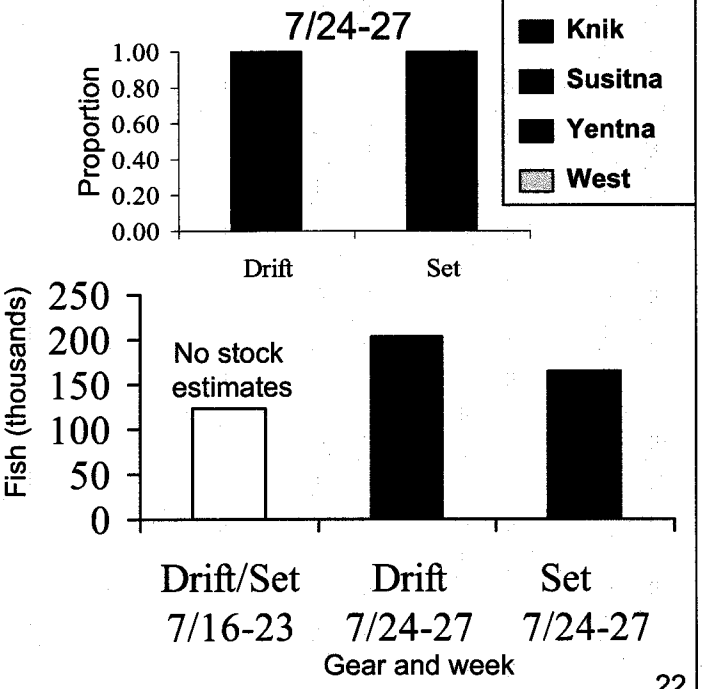




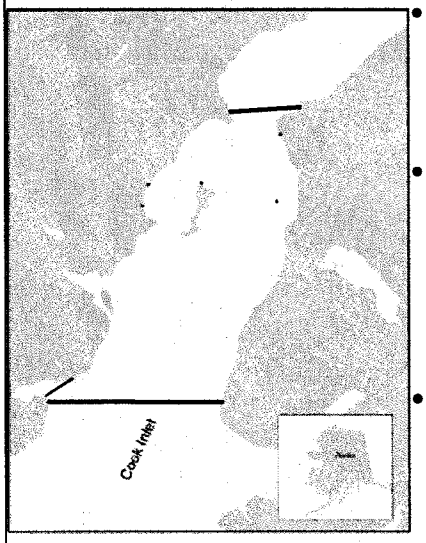
Kasilof Terminal Area

No early period estimates





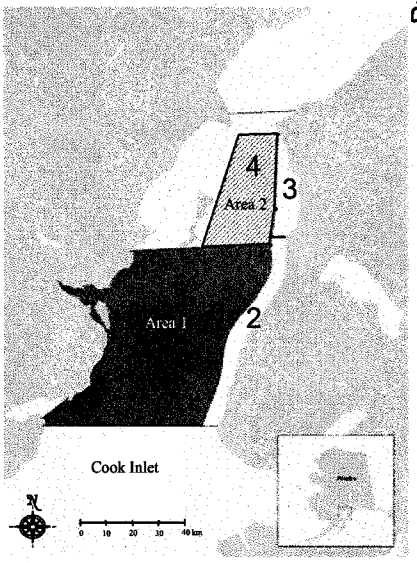
Central District Drift - methods

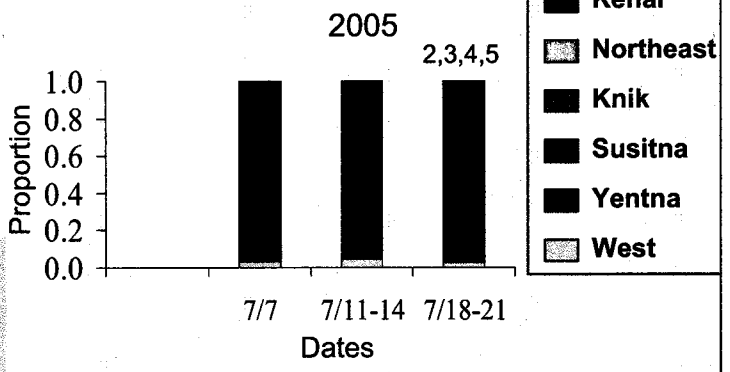


- 2005
  - One processor
  - 50-200 samples from each opening
  - 5-10 samples from each of 10-20 boats
- 2006 and 2007
  - Three processors
  - 130 fish minimum target per processor per opening
  - Systematic sampling many boats
  - Same proportion of catch at all processors
- Analyzed samples through July 21
  - 12 mixtures
  - 200 to 400 fish per mixture
  - Proportional to catch in 2006 and 2007

Central District Drift

2005: mostly Kenai





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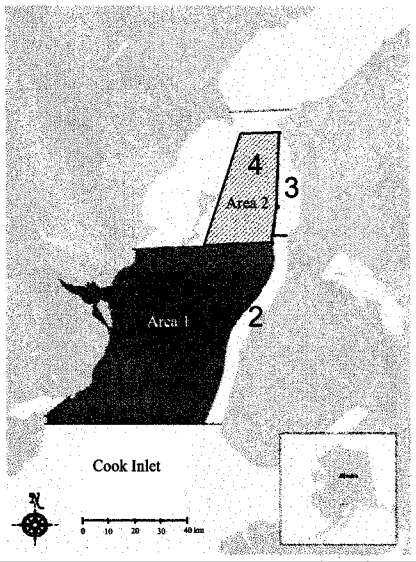
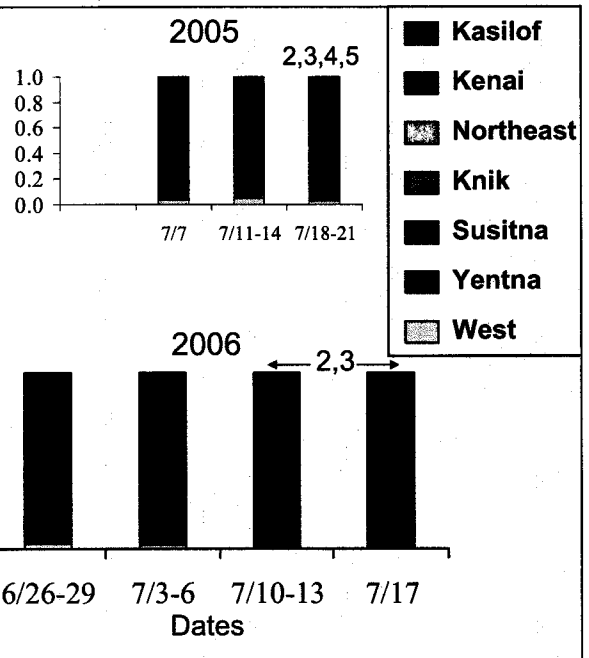
Central District Drift

2006: mostly Kasilof





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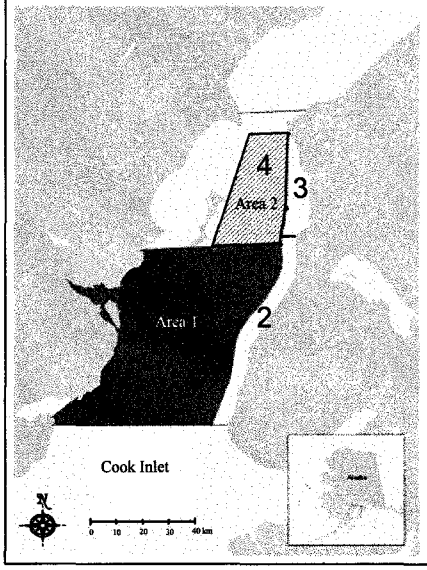
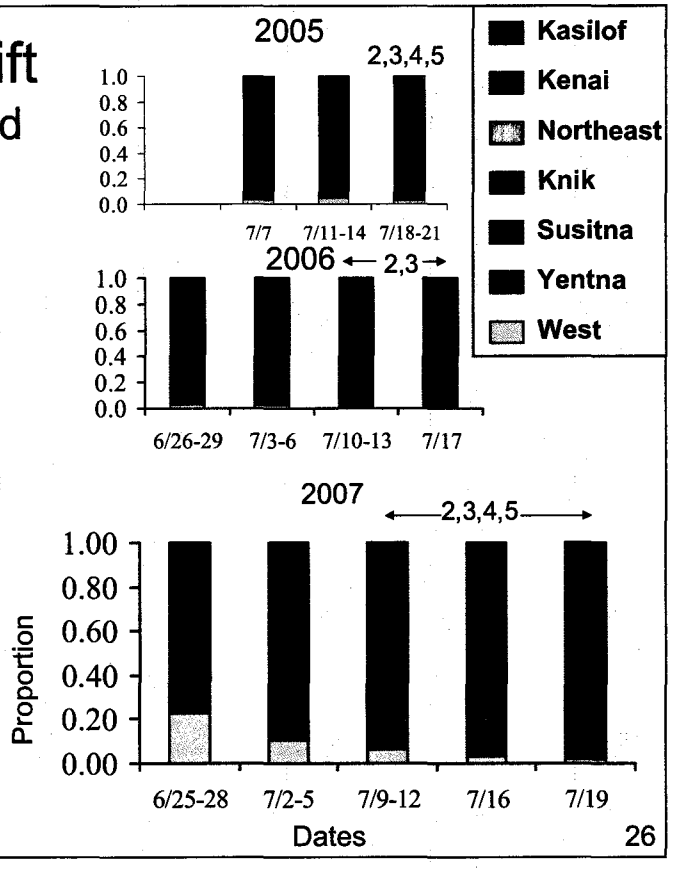
Central District Drift

2007: more western and northern fish

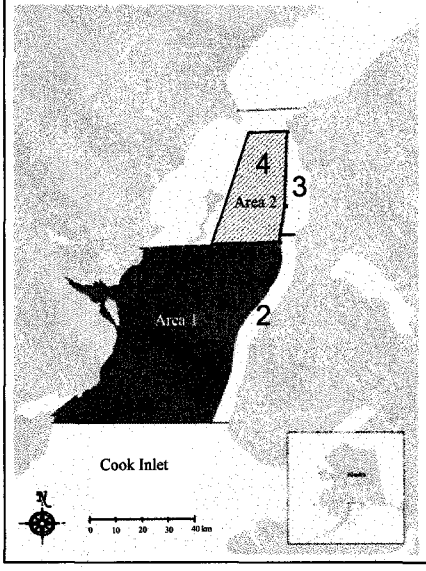


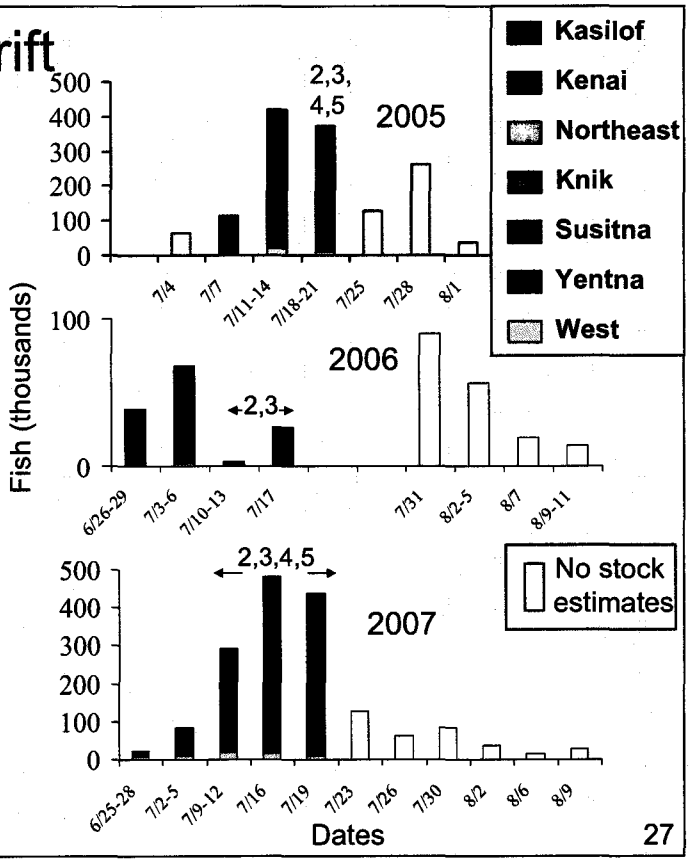


26

Central District Drift

Estimates through July 21





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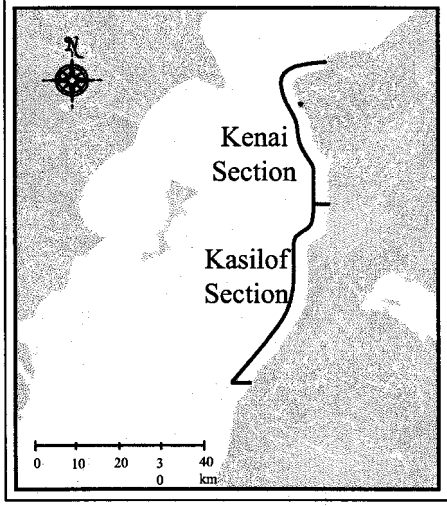
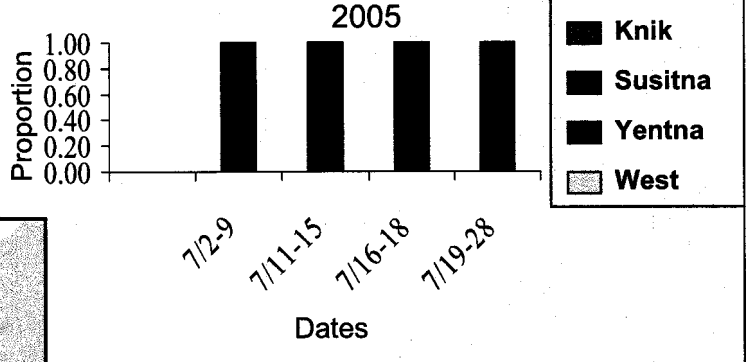
Kenai and Kasilof Section Set - methods

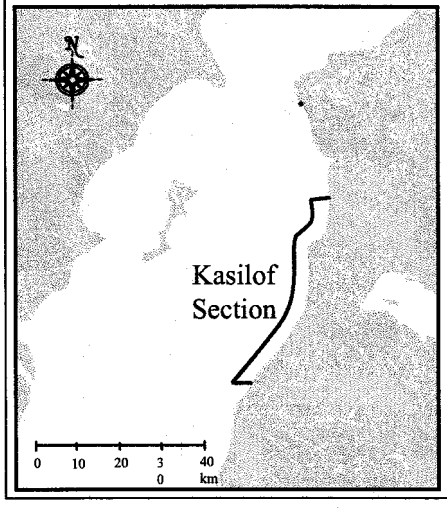
- 2005
  - All buying stations
  - Both tides
  - In proportion to historical averages
- 2006 and 2007
  - All buying stations
  - Both tides
  - Over-sampled to allow sub-sampling in proportion with actual harvests post season
- Analyzed samples through July 27
  - 23 mixtures
  - 200 to 400 fish per mixture
  - Proportional to harvest within period in 2006 and 2007



Kasilof Section Set

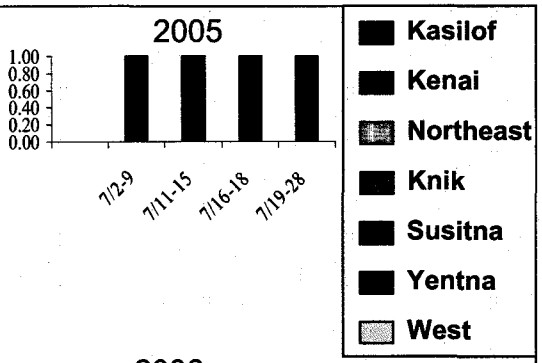
2005: 99% Kenai and Kasilof

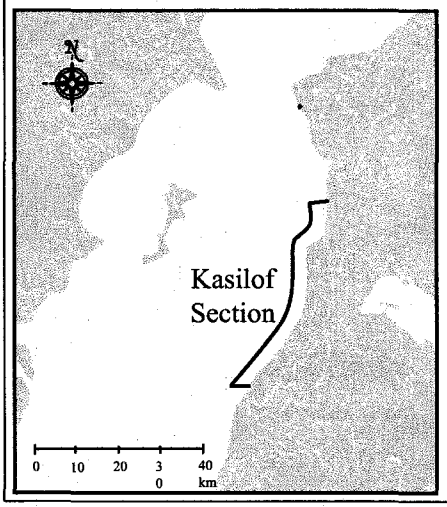


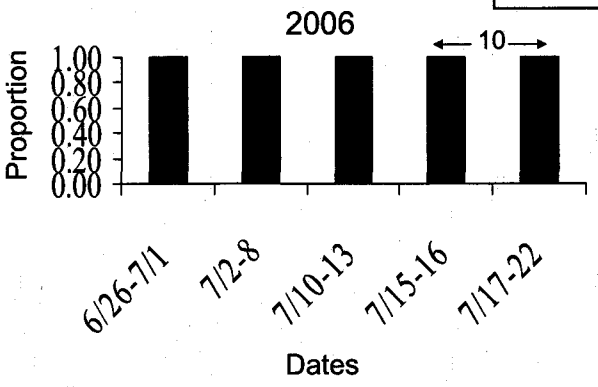


Kasilof Section Set

2006: 99% Kenai and Kasilof







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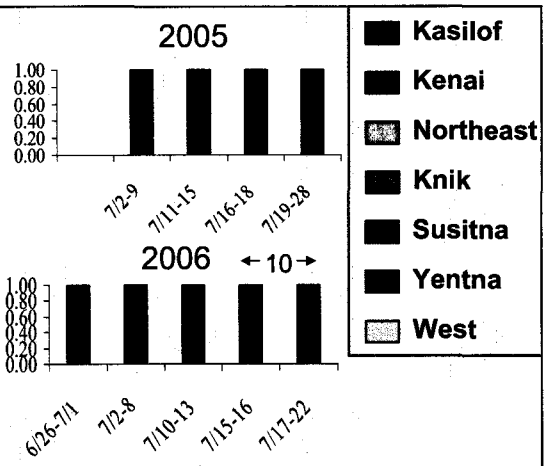
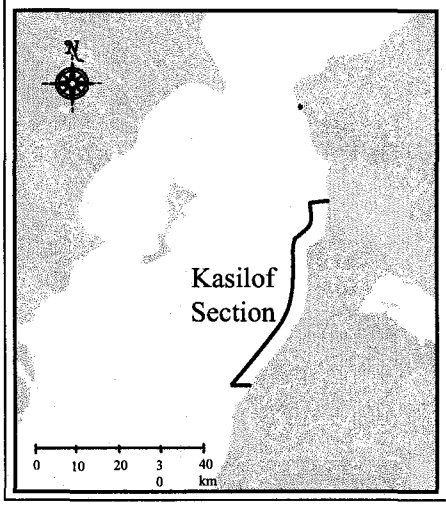
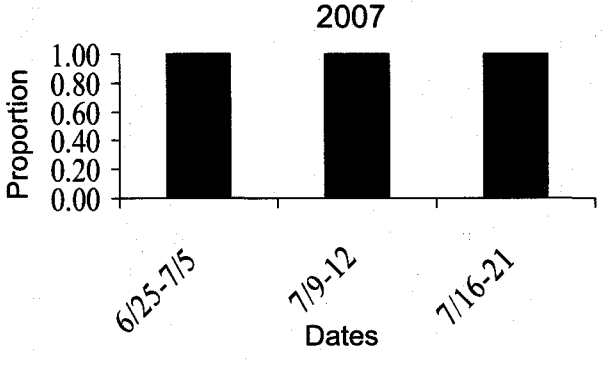
Kasilof Section Set

2007: 5-10% northern fish







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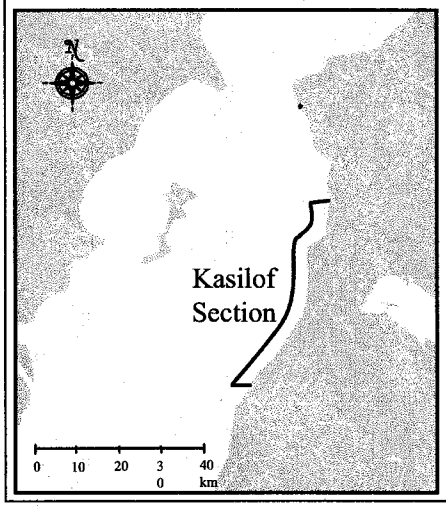
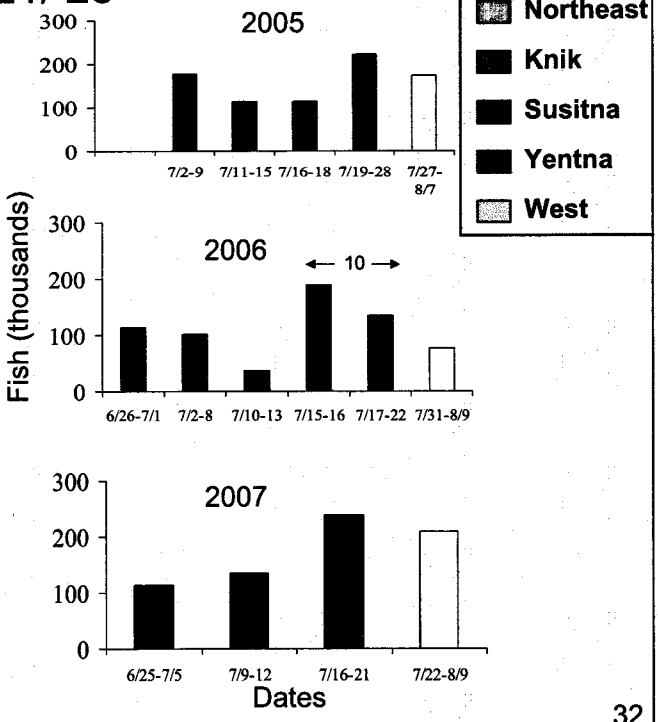
Kasilof Section Set

Estimates through July 21/ 28





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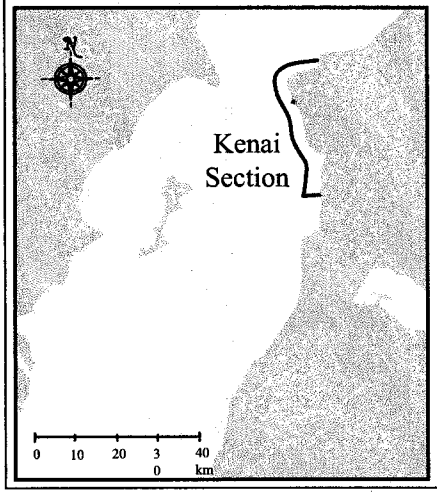
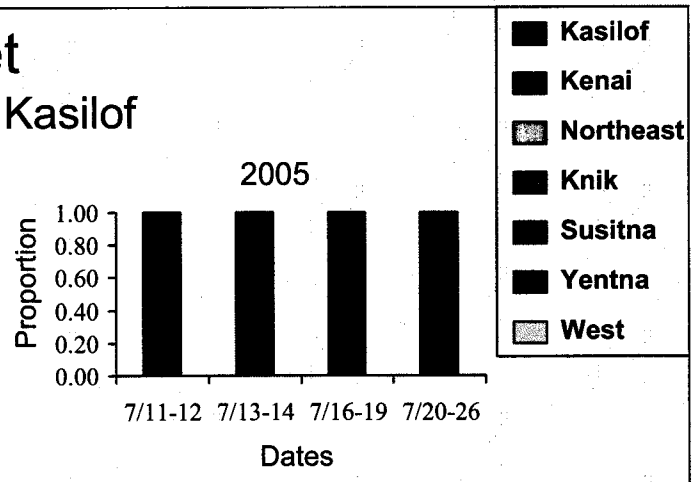
Kenai Section Set

2005: 99% Kenai and Kasilof





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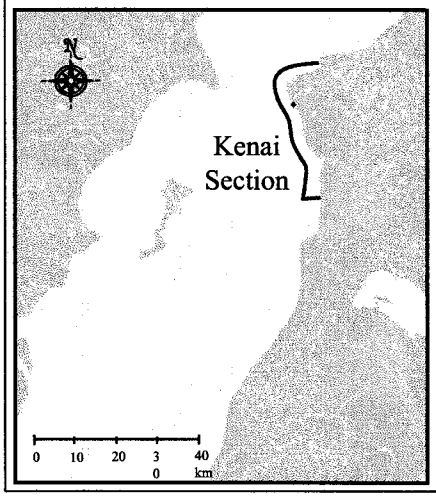
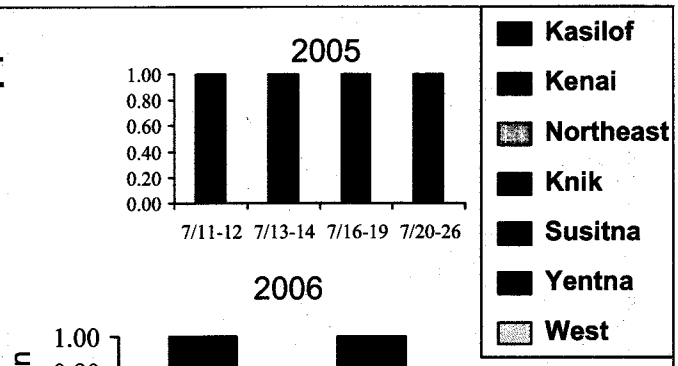
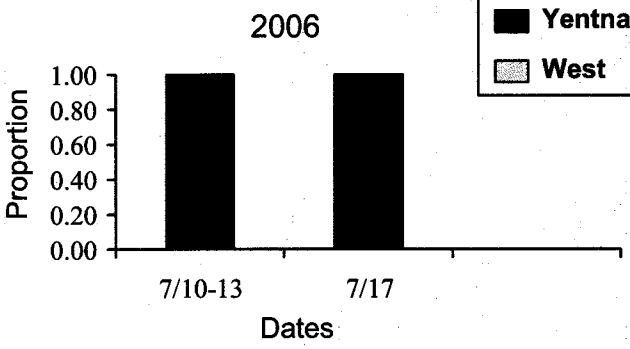
Kenai Section Set

2006: 99+% Kenai and Kasilof







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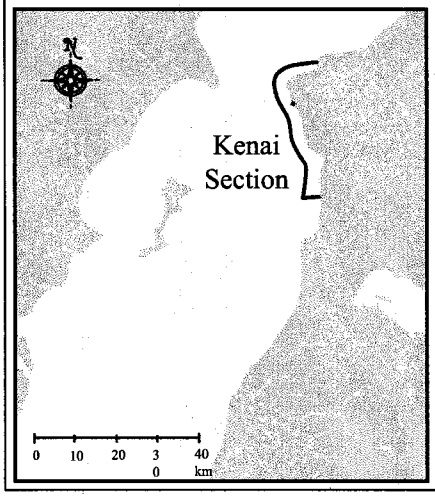
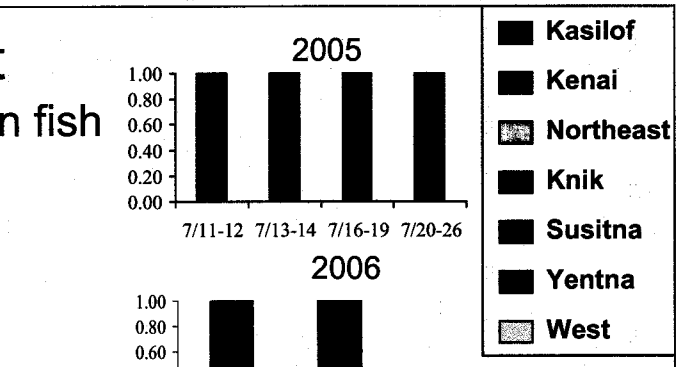
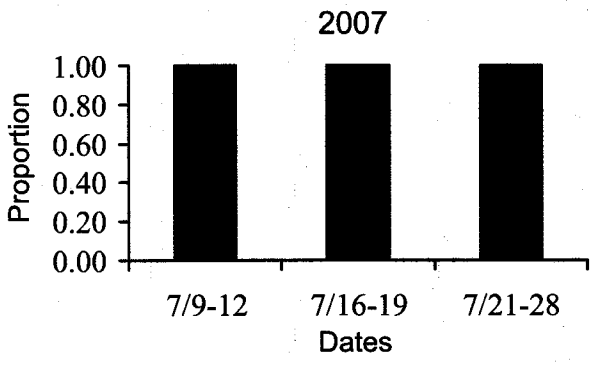
Kenai Section Set

2007: 4%-16% northern fish







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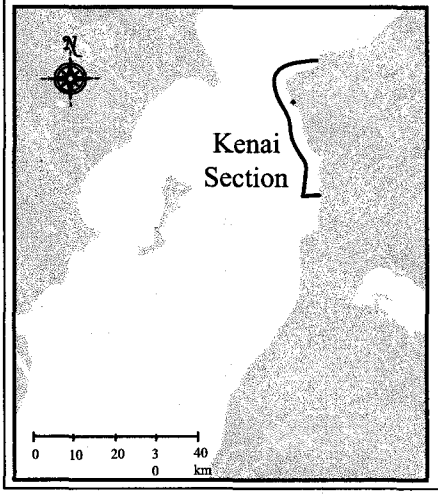
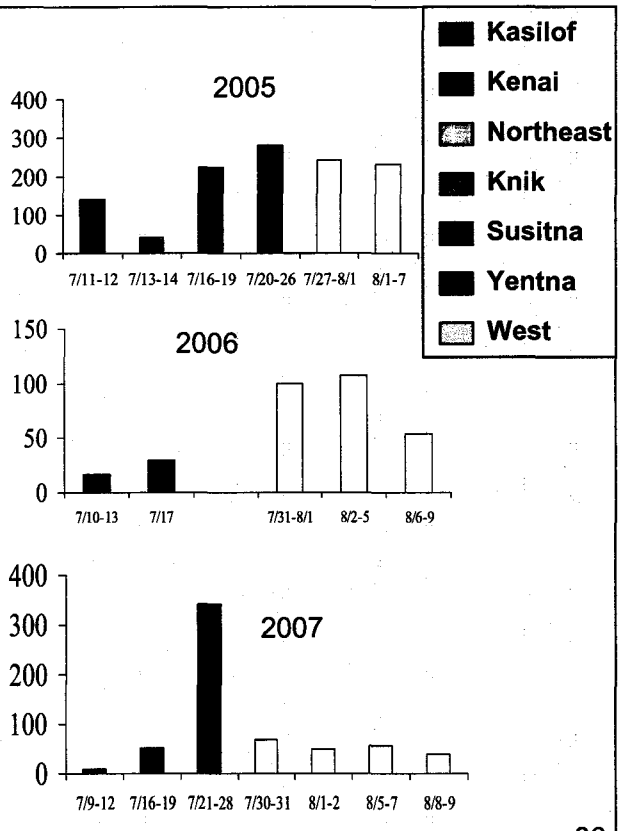
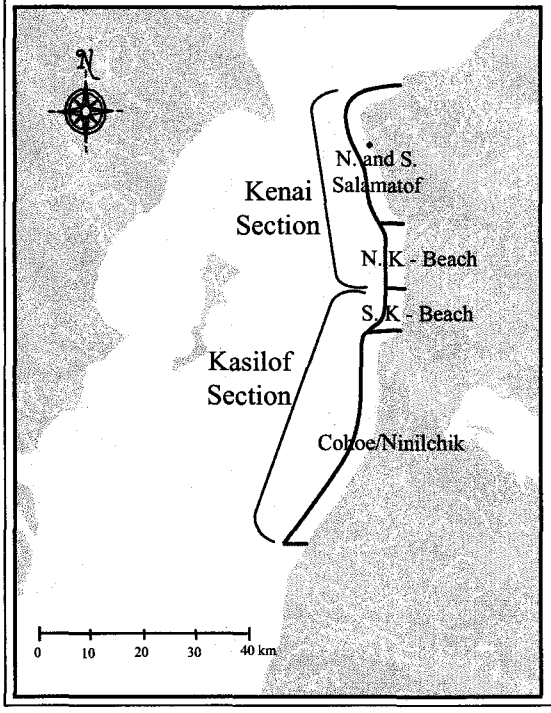
Kenai Section Set

Estimates through 7/26-28





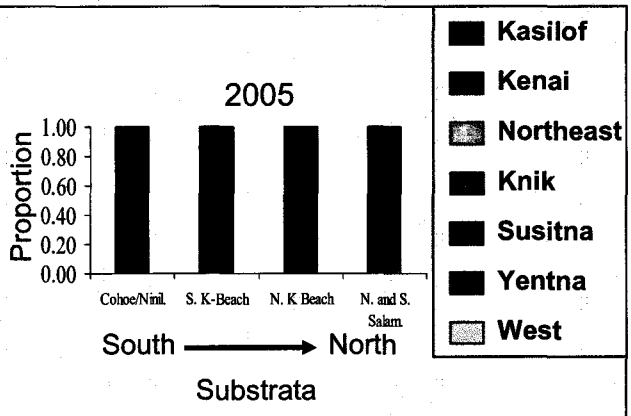
Kenai and Kasilof Substrata - methods

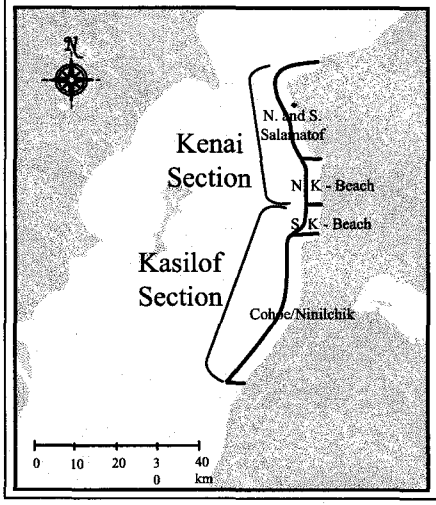


- Divided Kenai and Kasilof Sections into two substrata each
- Pooled all samples within each substrata within years
- Analyzed samples through July 27
  - 12 mixtures
  - 189 to 1,335 fish per mixture
  - Not proportional to harvest among days

Within Kenai and Kasilof Sections

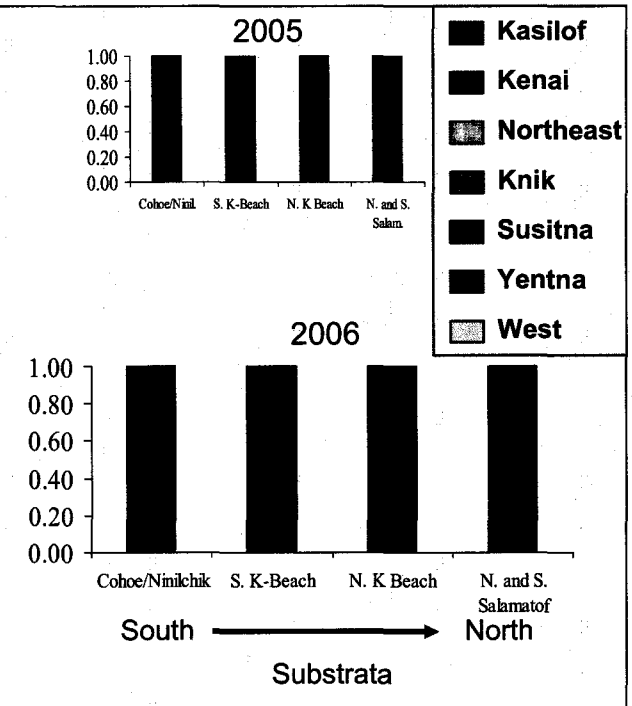
2005: stocks abundant near river of origin

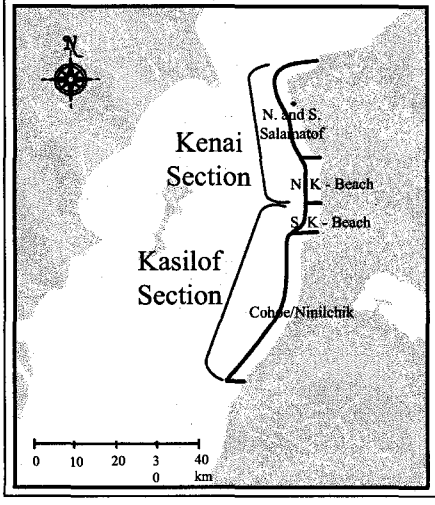




Within Kenai and Kasilof Sections

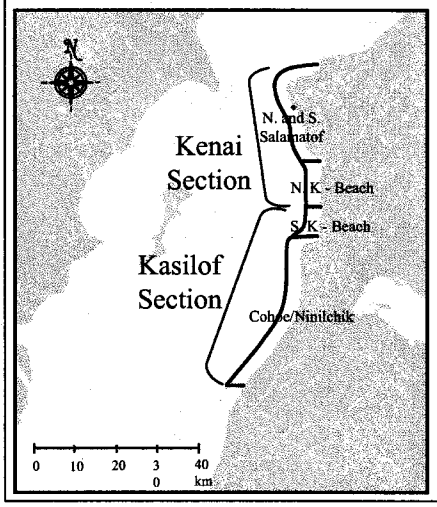
2006: stocks abundant near river of origin

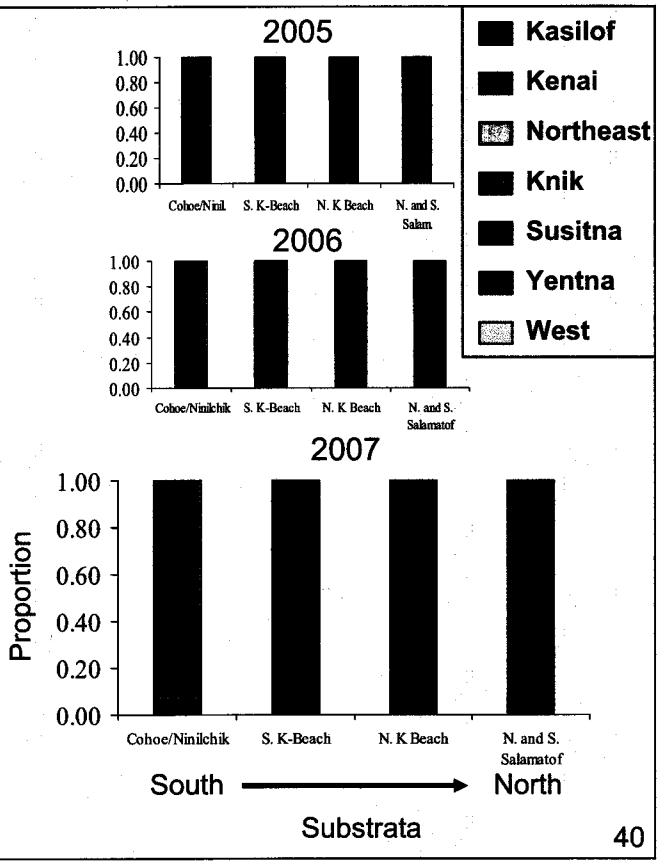




Within Kenai and Kasilof Sections

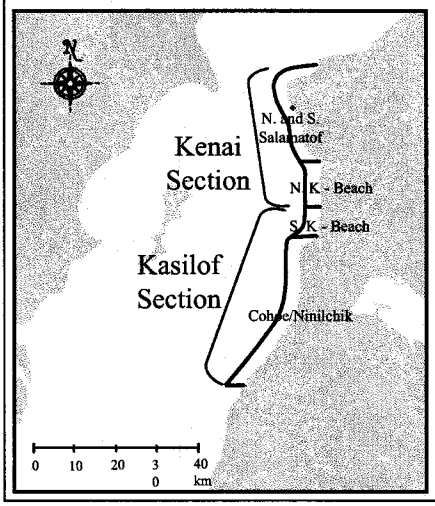
2007: Stocks abundant near river of origin

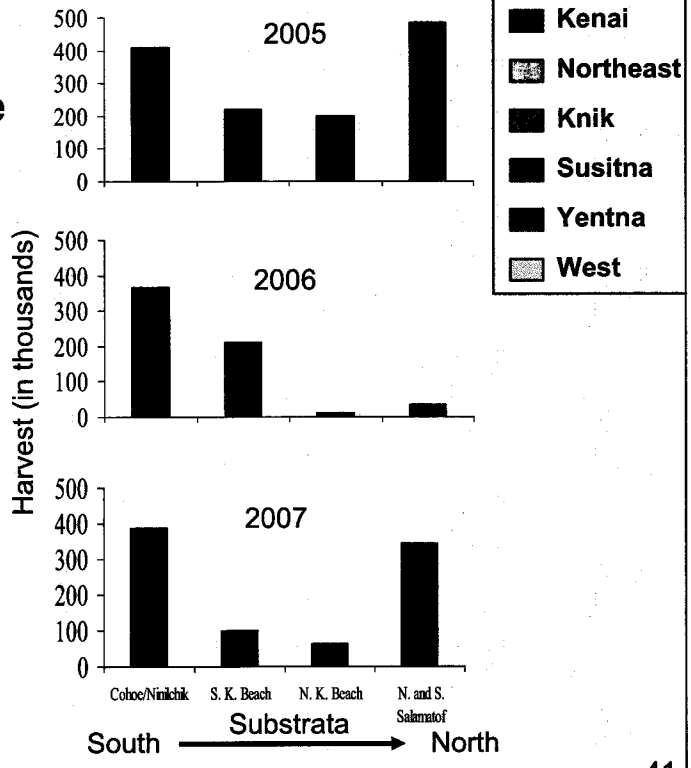




Within the Kenai and Kasilof Sections

Larger harvest outside K-beach



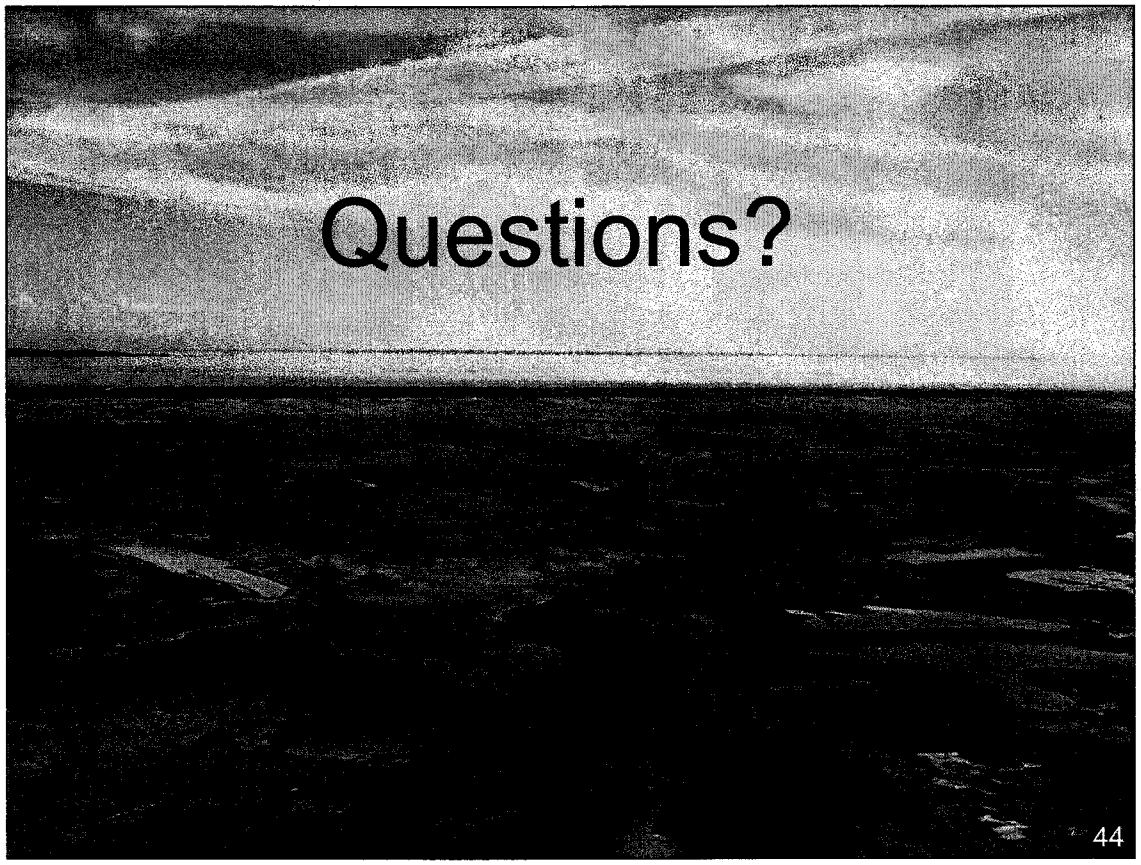


Take-home messages

- High year-to-year variation
  - Additional years needed to understand stock abundance through time and space
- Between-year patterns follow abundance trends
  - Kasilof proportions high in 2006
  - Kenai proportions high in 2005 and 2007
- Within-year patterns follow known migration timing
  - Kasilof proportions high early
  - Kenai proportions high late

Where from here?

- Proposal to Pacific Coast Salmon Recovery Fund
  - Finish out 2005, 2006, and 2007
  - Incorporate into brood tables
- Continue with State General funds
  - 2008 and forward
  - Continued but fewer baseline
- Controlled studies to examine variables under management control?
  - Area
  - Timing


Questions?
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