Factors Affecting Harvest and Fishing Effort in the Anadromous Striped Bass Fishery of California

by Jason DuBois
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Jason DuBois Date 10-08-09
Jason DuBois

My name is Jason DuBois, and I am a Fisheries Biologist with the California Department of Fish and Game. I work in the Sport Fish Unit within Region 3 (Bay-Delta, Stockton Office). I collect and analyze data on abundance and catch of anadromous adult striped bass in California. I have a BA in Marine Biology from the University of California at Santa Cruz and have worked for the Department in my current position for two and a half years (see curriculum vitae, Exhibit A).

I have not been specifically compensated by any person or entity for this report or my testimony in this case. I have not testified as an expert witness at trial or deposition in any matter in the past four years.

Introduction

I was asked to provide expert testimony regarding the behavior of anglers as related to the 1982 changes to striped bass fishing regulations[1] and to adult striped bass abundance. I reviewed data on adult striped bass annual estimates of abundance and estimates of catch. I also reviewed data from commercial passenger fishing vessels (CPFV) on adult striped bass relative abundance, fishing effort, and the number of fish kept.

Data for abundance and harvest estimates have been collected through the Department's adult striped bass mark (tagging)/recapture program. This dataset provides critical information related to the number (abundance) and catch of anadromous adult striped bass in California. I refer to this dataset as system-wide.

Captains of commercial passenger fishing vessels are required by law to report the number of anglers fishing, the total hours fished, and the number of fish caught. I used CPFV data compiled by Kathy Hieb of the California Department of Fish and Game. This dataset provides information on annual totals for number of hours fished for striped bass (angler-hours) and number of striped bass kept (fish kept). I only used data from successful fishing trips (where anglers caught fish) made inside the Golden Gate. I refer to this dataset as CPFV.

I analyzed system-wide and CPFV datasets in order to have two independent estimates of abundance. For both datasets, I reviewed data from 1980 – 2008. Striped bass fishing regulations changed only once (in 1982) during this period. I organized this report in the following sections:

I. Explanation of Simple Linear Regression
II. Data Table (Exhibit B)
III. Abundance Estimates and Catch (Exhibit C, Plots 1 and 2)
IV. Catch Per Unit Effort (CPUE) and Catch (Exhibit D, Plots 1 and 2)
V. Abundance Estimates and Angler-hours (Exhibit E, Plots 1 and 2)
VI. Abundance Estimates and Fish Kept (Exhibit F, Plots 1 and 2)
VII. Conclusion
VIII. Literature Cited

Because I was asked to provide information of angler behavior with regards to the 1982 fishing regulation change and to striped bass abundance, I plotted annual estimates of striped bass abundance (system-wide) separately with annual estimates of catch (system-wide), angler-hours (CPFV), and fish kept (CPFV) (see Sections II, IV, and V below). Also, I plotted annual estimates of catch per unit effort (CPUE, from CPFV) and estimates of catch (system-wide) (see Section III below). I marked on each plot the year of the regulation change and observed the trend in the data pre and post change.

I also performed a simple linear regression on each of the dataset pairings previously mentioned above (see "Explanation of Simple Linear Regression" section below for a brief synopsis of

[1] I assumed these regulations to have been in effect on March 1, 1982.

simple linear regression). Analysis of each simple linear regression is provided below (see Sections II – V).

Based on the information I have read and presented below, it is my professional opinion that as striped bass abundance increased, anglers spent more time fishing and caught more striped bass. Similarly, as striped bass abundance decreased, anglers spent less time fishing and caught less striped bass. I do not see any evidence the 1982 changes to striped bass fishing regulations influenced angler behavior. The four plots (Exhibits C – F, Plot 1) do not reveal any obvious shift or shifts that could be attributed solely to changes in fishing regulations. Additionally, simple linear regression analyses indicate angler behavior was driven in large part by striped bass abundance.

Section I – Explanation of Simple Linear Regression

Simple linear regression is a useful and statistically sound tool for comparing the relationship between two variables. For example, I used simple linear regression to observe the effects of striped bass abundance on catch. Three important statistical values are obtained from simple linear regression: the p-value, the sample correlation coefficient (R), and the coefficient of determination (R^2). These values provide guidance when interpreting the relation between the two variables.

We accept or reject the slope of the linear regression line as equal to zero based on the size of the p-value. The lower the p-value the more confidence we have in rejecting the slope as equal to zero. A p-value of less than 0.01 is a reasonable rationale for rejecting the slope as equal to zero.

The sample correlation coefficient (R) describes the degree of linear relationship between two variables. The range of R is -1 to +1. A value of -1 means all values align on a straight line with a downward (negative) slope. A value of +1 means all values align on a straight line with an upward (positive) slope. A value of 0 means there is no linear relation.

The coefficient of determination (R^2) describes the percentage (or proportion) of variation in the Y-axis variable explained by the fitted regression line. The lower the R^2 value, the less the fitted regression line explains the variation.

Section II – Data Table

Exhibit B (Data Table) contains the following data fields: Abundance Estimates; Catch; CPUE; Fish Kept; and Angler-Hours.

Abundance estimates (N) are from a mark (tagging)/recapture study and are calculated using a Bailey-modified version of the Petersen equation (Ricker 1975).

$$N = \frac{(M(C+1))}{(R+1)}$$

The “M” in the equation is the number of fish marked (tagged). The “C” in the equation is the number of fish caught (from angler catch or tagging efforts). The “R” in the equation is the number of tagged fish recaptured (from angler catch or tagging efforts).

Catch is estimated using the formula below.

$$\text{Catch} = (\text{abundance estimate}) \times (\text{annual harvest rate estimate})$$

Angler-hours are the sum of the number of hours anglers fished each year. Fish kept is the sum of the number of fish kept by anglers each year.

Catch per unit effort (CPUE) is a measure of relative adult striped bass abundance and is calculated per 100 angler-hours. I only used data from trips made within the Golden Gate and from trips where anglers caught striped bass.

$$\text{CPUE} = 100 \times \left[\frac{\text{Fish Kept}}{\text{Angler hours}} \right]$$

Section III – Abundance Estimates and Catch
I plotted annual estimates (1980 – 2007) of striped bass abundance and catch (Exhibit C, Plot 1) and a simple linear regression of abundance estimates versus catch (Exhibit C, Plot 2).

The red line in Plot 1 of Exhibit C indicates the change in fishing regulations in 1982. There was substantial year-to-year variation in catch. The greatest such variation occurred from 1982 to 1983. The decline in catch the year following the change in regulations (1983) was typical of year-to-year declines from 1983 to 1989. Catch increased year-to-year from 1994 to 1998.

Simple linear regression analysis (Exhibit C Plot 2) provides the following statistics: p-value = 0.00017; R = 0.7053; and R^2 = 0.4975. My interpretation and analysis of these linear regression statistics are as follows. The low p-value indicates a high probability the slope of the linear regression line is not zero. The R value indicates a good degree of positive linear association between striped bass abundance and catch. The R^2 value indicates about 50% of the variation in catch is explained by the linear regression on abundance.

Based on my interpretation and analysis of Exhibit C Plot 2, I conclude that as striped bass abundance increased catch increased or as striped bass abundance decreased catch decreased. Given that up to 50% of the variation in catch is explained by the linear regression on abundance, I also conclude that factors other than abundance may have caused variation in catch. Similarly, errors within the estimates of striped bass abundance and catch may have caused the variation.

Section IV – CPUE and Catch
I plotted annual estimates (1980 – 2008) of striped bass CPUE and catch (Exhibit D, Plot 1) and a simple linear regression of CPUE versus catch (Exhibit D, Plot 2).

The red line in Plot 1 of Exhibit D indicates the change in fishing regulations in 1982. There was substantial year-to-year variation in catch. The greatest such variation occurred from 1982 to 1983. The decline in catch the year following the change in regulations (1983) was typical of year-to-year declines from 1983 to 1989. Catch increased year-to-year from 1994 to 1998.

Simple linear regression analysis (Exhibit D Plot 2) provides the following statistics: p-value = 0.001; R = 0.6286; and R^2 = 0.3952. My interpretation and analysis of these linear regression statistics are as follows. The low p-value indicates a high probability the slope of the linear regression line is not zero. The R value indicates a good degree of positive linear association between CPUE and catch. The R^2 value indicates about 40% of the variation in catch is explained by the linear regression on CPUE.

Based on my interpretation and analysis of Exhibit D Plot 2, I conclude that as CPUE increased catch increased or as CPUE decreased catch decreased. Given that up to 40% of the variation in catch is explained by the linear regression on CPUE, I also conclude that factors other than CPUE (relative abundance) may have caused variation in catch. Similarly, errors within the estimates of CPUE and catch may have caused the variation.

Section V – Abundance Estimates and Angler-hours
I plotted annual estimates (1980 – 2008) of striped bass abundance estimates and angler-hours

(Exhibit E, Plot 1) and a simple linear regression of abundance estimates versus angler-hours (Exhibit E, Plot 2).

The red line in Plot 1 of Exhibit E indicates the change in fishing regulations in 1982. There was often strong year-to-year variation in angler-hours. The greatest such variations occurred from 1982 to 1983 and 2007 to 2008. Angler-hours increased for two years (1983 and 1984) following the 1982 regulation change. Angler-hours decreased annually from 1984 to 1992. Angler-hours increased year-to-year from 1992 to 1996.

Simple linear regression analysis (Exhibit E Plot 2) provides the following statistics: p-value = 0.008; R = 0.5419; and R^2 = 0.2937. My interpretation and analysis of these linear regression statistics are as follows. The low p-value indicates a high probability the slope of the linear regression line is not zero. The R value indicates a good degree of positive linear association between abundance and angler-hours. The R^2 value indicates about 30% of the variation in angler-hours is explained by the linear regression on abundance.

Based on my interpretation and analysis of Exhibit E Plot 2, I conclude that as striped bass abundance increased angler-hours increased or as striped bass abundance decreased angler-hours decreased. Given that up to 30% of the variation in angler-hours is explained by the linear regression on abundance, I also conclude that factors other than abundance may have caused variation in angler-hours. Similarly, errors within the estimates of abundance and angler-hours may have caused the variation.

Section VI – Abundance Estimates and Fish Kept

I plotted annual estimates (1980 – 2008) of striped bass abundance and fish kept (Exhibit F, Plot 1) and a simple linear regression of abundance estimates versus fish kept (Exhibit F, Plot 2).

The red line in Plot 1 of Exhibit F indicates the change in fishing regulations in 1982. There was often strong year-to-year variation in fish kept. The greatest such variations occurred from 1982 to 1983, 1997 to 1998, and 1999 to 2000. Fish kept increased for two years (1983 and 1984) following the 1982 regulation change. Fish kept decreased annually from 1984 to 1986 and again from 1987 to 1992. Fish kept increased steadily year-to-year from 1992 to 1998.

Simple linear regression analysis (Exhibit F Plot 2) provides the following statistics: p-value = 0.00045; R = 0.6712; and R^2 = 0.4505. My interpretation and analysis of these linear regression statistics are as follows. The low p-value indicates a high probability the slope of the linear regression line is not zero. The R value indicates a good degree of positive linear association between abundance and fish kept. The R^2 value indicates about 45% of the variation in fish kept is explained by the linear regression on abundance.

Based on my interpretation and analysis of Exhibit F Plot 2, I conclude that as striped bass abundance increased the number of fish kept increased or as striped bass abundance decreased the number of fish kept decreased. Given that up to 45% of the variation in fish kept is explained by the linear regression on abundance, I also conclude that factors other than abundance may have caused variation in fish kept. Similarly, errors within the estimates of abundance and fish kept may have caused the variation.

Section VII – Conclusion

I was asked to provide expert testimony regarding the behavior of anglers as related to the 1982 changes to striped bass fishing regulations and to adult striped bass abundance. It is my professional opinion that as striped bass abundance increased, anglers spent more time fishing and caught more striped bass. Similarly, as striped bass abundance decreased, anglers spent less time fishing and caught less striped bass.

I do not see any evidence the 1982 changes to striped bass fishing regulations influenced angler behavior. The four plots (Exhibits C – F, Plot 1) do not reveal an obvious shift that could be attributed solely to changes in fishing regulations. Additionally, simple linear regression analyses indicate angler behavior is driven in large part by striped bass abundance.

Simple linear regression analyses support my interpretation. Other experts have noted similar findings. Stevens (1980) stated catch appears to change directly with striped bass abundance. Furthermore, Stevens (1980) concluded when interpreting Miller (1974) that trends in fishing effort are comparable to trends in fishing success. However, these linear regression analyses do not demonstrate abundance was the *only* factor involved. Other factors might have influenced angler behavior. Other factors might have included but were not limited to, economics (e.g., price of fuel, price of fishing equipment), abundance of other species of sport fish (e.g., salmon or halibut), or variation within the estimates themselves. I did not analyze the effects of these other factors on angler behavior.

Section VIII – Literature Cited

Miller, L. W. 1974. *Mortality Rates for California Striped Bass (Morone saxatilis) from 1965 – 1971*. California Fish and Game, 60(4), Pages 157 – 171.

Ricker, W. E. 1975. *Computation and Interpretation of Biological Statistics of Fish Populations*. Department of the Environment Fisheries and Marine Science. Bulletin 191. Page 78.

Stevens, D. E. 1980. *Factors Affecting the Striped Bass Fisheries of the West Coast*. *in* F. E. Carlton and H. Clepper, Marine Recreational Fisheries, Proceeding of the Fifth Annual Marine Recreational Fisheries Symposium, Boston, Massachusetts, March 27 – 28, 1980. Pages 15 – 27.

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Jason DuBois

Education

Bachelor of Arts, Marine Biology, University of California at Santa Cruz, June 1990
Senior Thesis Research Project: Analysis of Lipid Content and Natural Diets of the Sea Anemone, *Anthopleura elegantissima*, Advisor: Dr. Don Potts

Professional Experience

California Department of Fish and Game

2007−Present: Biologist (Marine/Fisheries), Responsibilities: Use mark and recapture techniques to estimate populations of striped bass and green and white sturgeon. Assist with telemetry study monitoring predatory fish migration in and around the State and Federal Fish Salvage Release sites. Employ field sampling techniques, such as electro-fishing or gill netting, to capture striped bass and other predatory fish. Affix ultrasonic tag externally to fish. Download and maintain ultrasonic receiver array per established schedule.

2004-2005, 2005-2006: Scientific Aide, Responsibilities: Assisted with the research of three main studies assessing the viability of delta smelt exposed to the collection, handling, transport, and release (CHTR) components of the fish salvage process at the Skinner Fish Facility (Byron, CA): Sub Lethal Stress Effect, Acute Mortality and Injury, and Fish Predation. Used purse seine and lampara nets to collect wild delta smelt per studies of the CHTR process. Handled, enumerated, measured, and identified juvenile and adult species of fish found in the Sacramento-San Joaquin Delta. Created and maintained Microsoft Excel spreadsheets used to collect and analyze data. Maintained aquaria used to keep wild and cultured delta smelt. Performed stomach removal from predators (for example striped bass, white catfish) per CHTR predation study.

U.S. Fish and Wildlife Service

2005, 2006: Biological Science Technician, Responsibilities: Assisted with daily field investigations relating to problems impacting anadromous salmonids and resident fishes of the Sacramento-San Joaquin Delta. Investigations included the use of beach seines and trawls to sample specified areas of the Delta and the Sacramento and San Joaquin rivers.

S.P. Cramer and Associates (Cramer Fish Sciences)

2006: BioTechnician 2, Responsibilities: Assisted with ongoing projects involving the study of salmon and steelhead migration within the Tuolumne, Stanislaus, and Calaveras rivers. Project involved the processing of fish captured in rotary screw traps located within the aforementioned rivers. Measured, weighed, identified, and recorded information of salmonid fry/parr/smolt and other fish species as captured by rotary screw traps. Used Microsoft Access to organize and maintain databases of information collected from field investigations.

Hanson Environmental, Inc.
2005: Biologist/Research Associate, Responsibilities: On-site biologist reporting to Woodbridge Irrigation District during construction of new Woodbridge Dam in the Mokelumne River at Woodbridge, CA. Performed daily monitoring of river to ensure that in-water construction did not adversely affect migratory salmon and/or steelhead. Work also included routine testing of turbidity at locations in the river upstream and downstream of in-water construction. Assisted with project work related to fish rescue. Work involved seining cofferdam for possible entrained fish. Summarized data related to Vernalis Adaptive Management Plan (VAMP) studies performed from 1998 to 2004.

Publications

Greiner, T., M. Fish, S. Slater, K. Hieb, J. Budrick, **J. DuBois**, and D. Contreras. 2007. *2006 Fishes Annual Status and Trends Report for the San Francisco Estuary*. Interagency Ecological Program for the Sacramento-San Joaquin Estuary Newsletter. 20 (2) pages 22 – 40.

Miranda, J., R. Padilla, G. Aasen, J. Morinaka, **J. DuBois**, B. Mefford, D. Sisneros, J. Boutwell, and M. Horn. (in review). *Survival of Fish in the Release Phase of the Fish Salvage Process*. California Natural Resources Agency – Department of Water Resources.

Presentations

Morinaka, J., **J. DuBois** (2008). "Element 2 - Predation As A Factor Contributing To Mortality At Release". CalFed Science Conference (Poster Presentation).

Relevant Skills

Electrofishing
Gill and Trammel nets
Underwater Telemetry
Motorboat Operation Certification Course (MOCC)
Microsoft Office
SCUBA Certified (PADI)

Professional Organizations

American Fisheries Society, Member

Professional Activities

American Fisheries Society 2007 Annual Meeting, Signs and Banners committee member

Exhibit B Data Table

Year	System-wide Data		CPFV Data		
	Abundance Estimates	Catch	CPUE	Fish Kept	Angler Hours
1980	1,115,999	137,268	9.69	1,348	13,915
1981	911,300	100,243	8.33	2,199	26,383
1982	825,126	131,195	6.81	1,861	27,317
1983	1,009,748	239,310	11.00	7,921	71,984
1984	1,048,243	233,758	12.41	9,354	75,368
1985	1,038,126	205,549	13.00	6,039	46,465
1986	1,064,142	173,455	7.18	2,208	30,771
1987	1,037,617	157,718	12.89	3,633	28,181
1988	967,290	128,650	8.05	1,670	20,744
1989	870,851	75,764	8.50	1,674	19,688
1990	651,494	82,088	9.91	1,638	16,527
1991	822,559	111,045	7.64	1,082	14,167
1992	777,293	72,288	8.02	1,057	13,175
1993	656,505	76,811	8.59	1,602	18,653
1994	599,770	52,780	8.54	2,063	24,161
1995			5.69	2,976	52,277
1996	1,043,239	106,410	7.23	5,937	82,087
1997			9.06	6,255	69,049
1998	1,356,412	271,282	13.36	12,683	94,934
1999			12.56	7,806	62,154
2000	1,591,419	173,465	15.17	13,820	91,105
2001			10.02	8,149	81,312
2002	945,878	125,862	8.24	5,466	66,356
2003	829,111	86,191	8.51	7,115	83,583
2004	1,312,452	156,303	10.97	5,236	47,714
2005	1,017,116	132,898	11.13	6,628	59,552
2006			5.60	2,126	37,944
2007	588,106	74,372	10.32	5,669	54,910
2008			8.47	9,956	117,488

Blank indicates no estimates for that year.

Exhibit C Plot 1

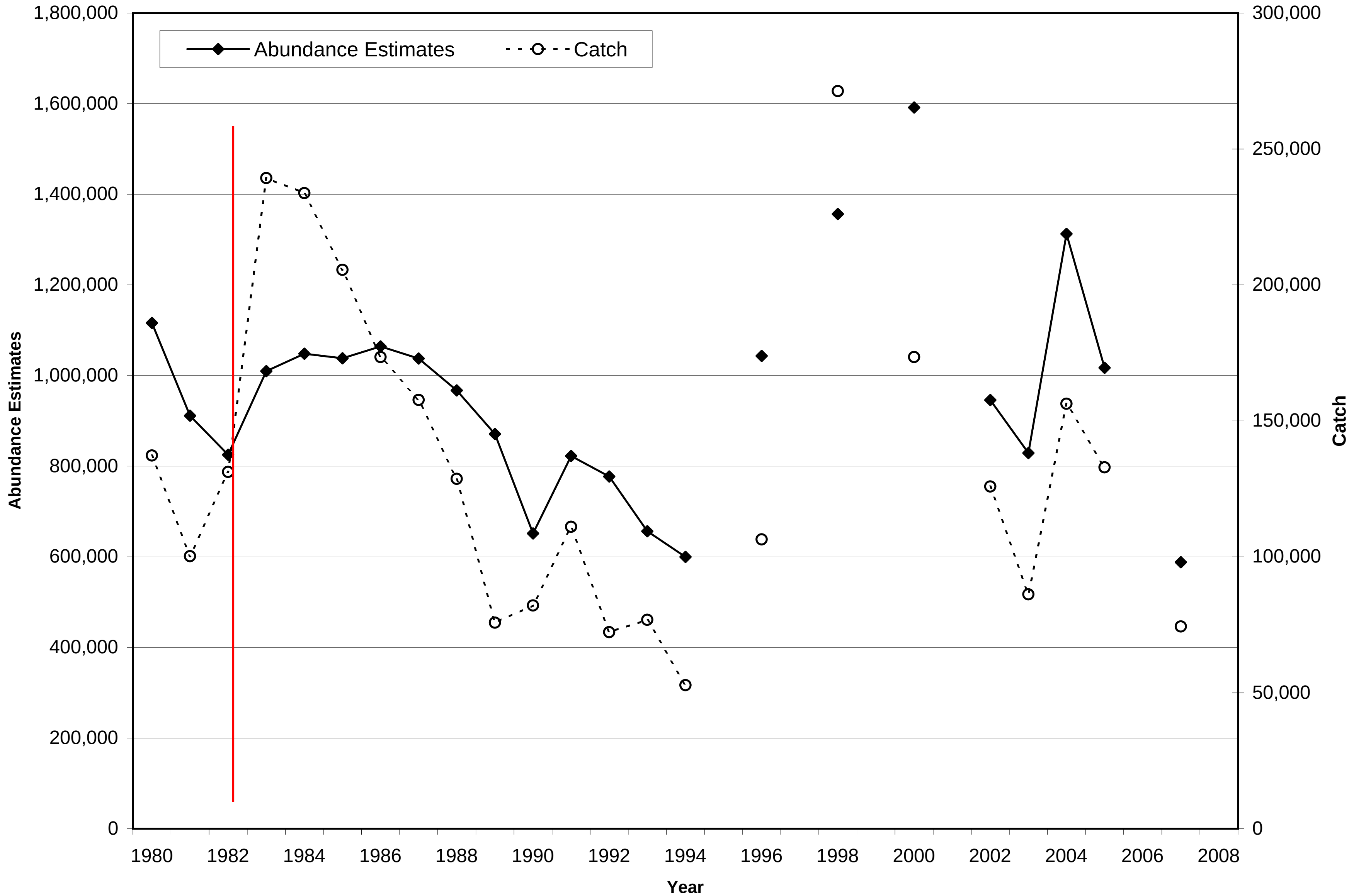


Exhibit C Plot 2

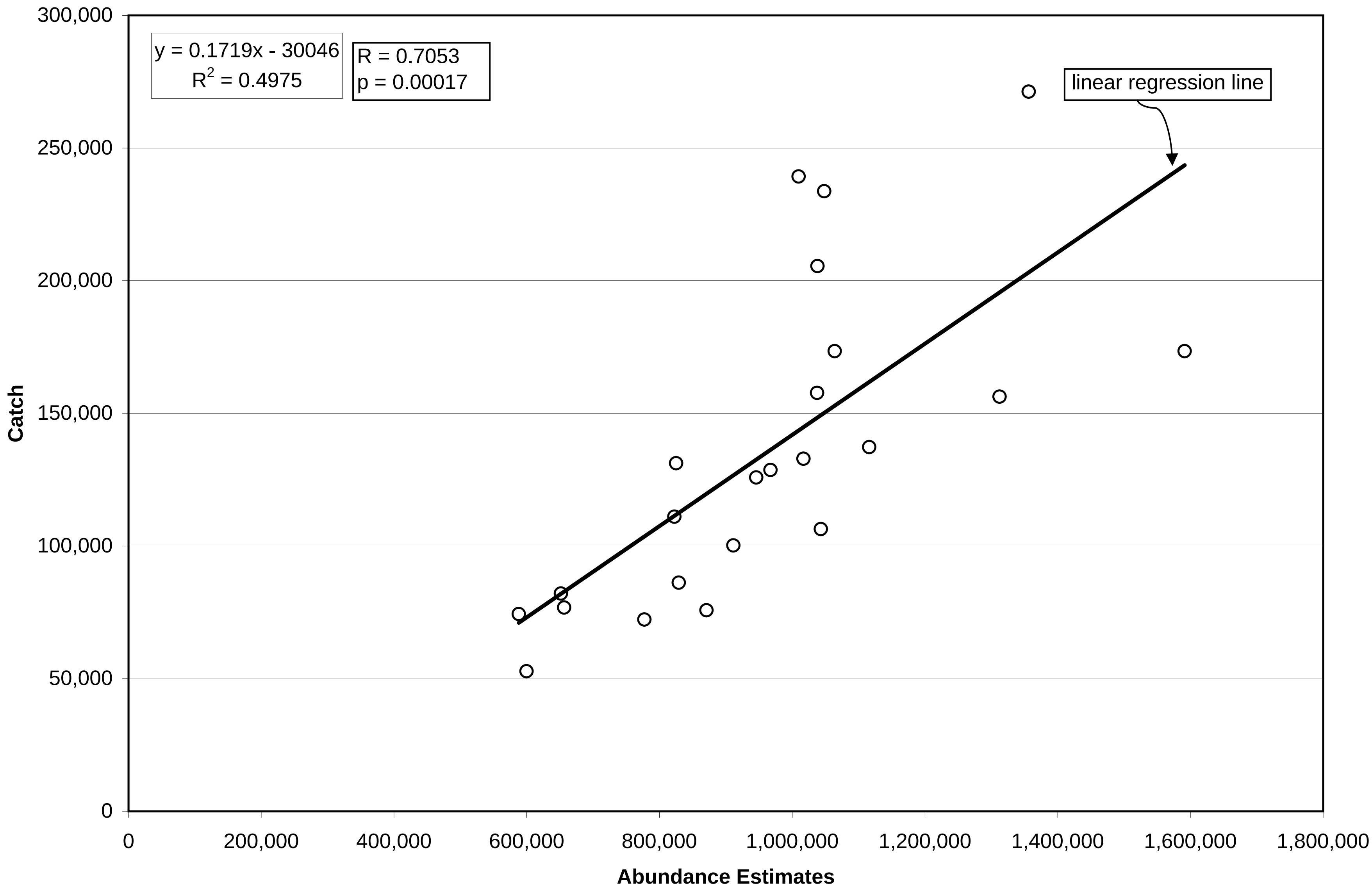
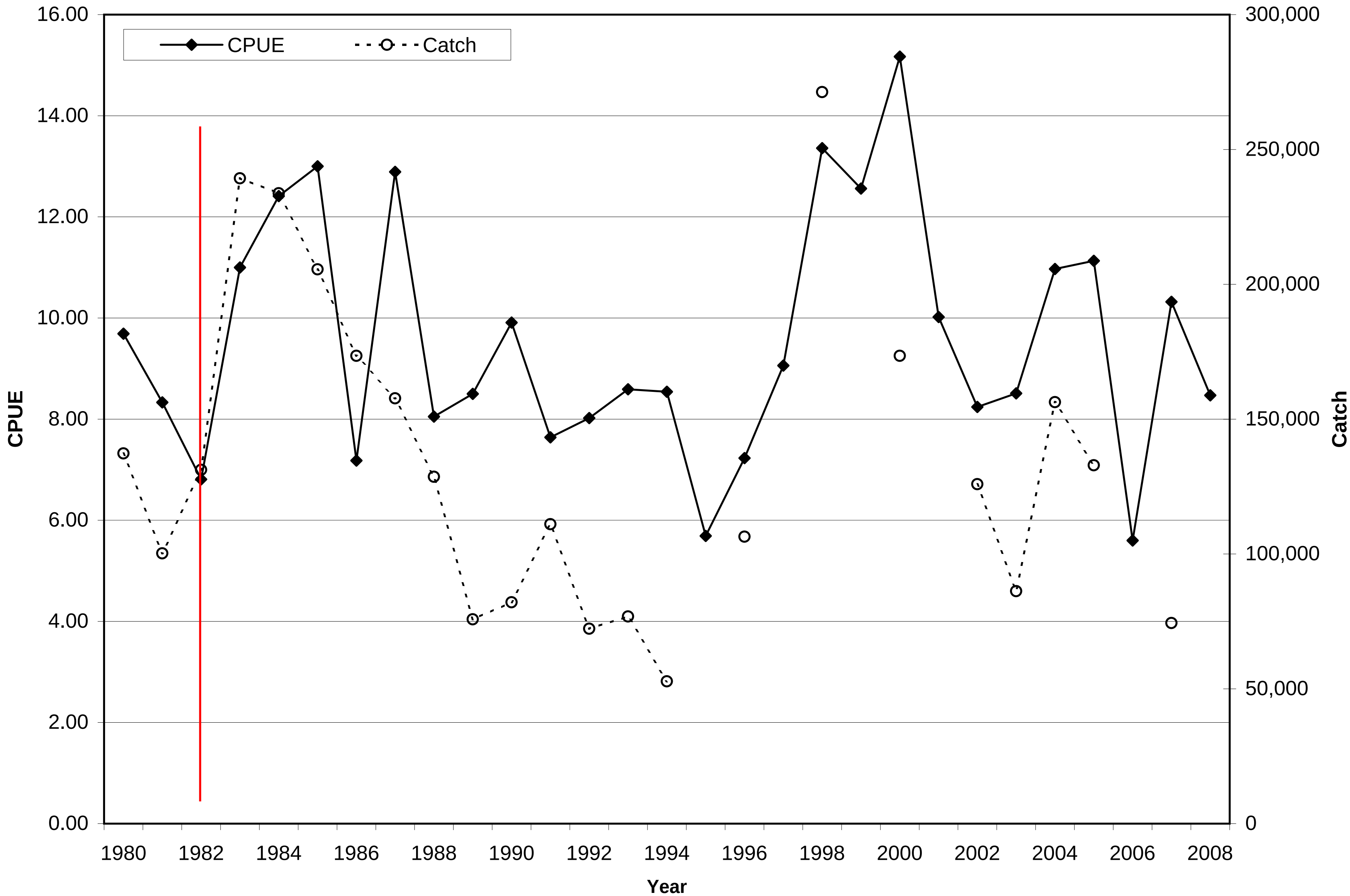


Exhibit D Plot 1



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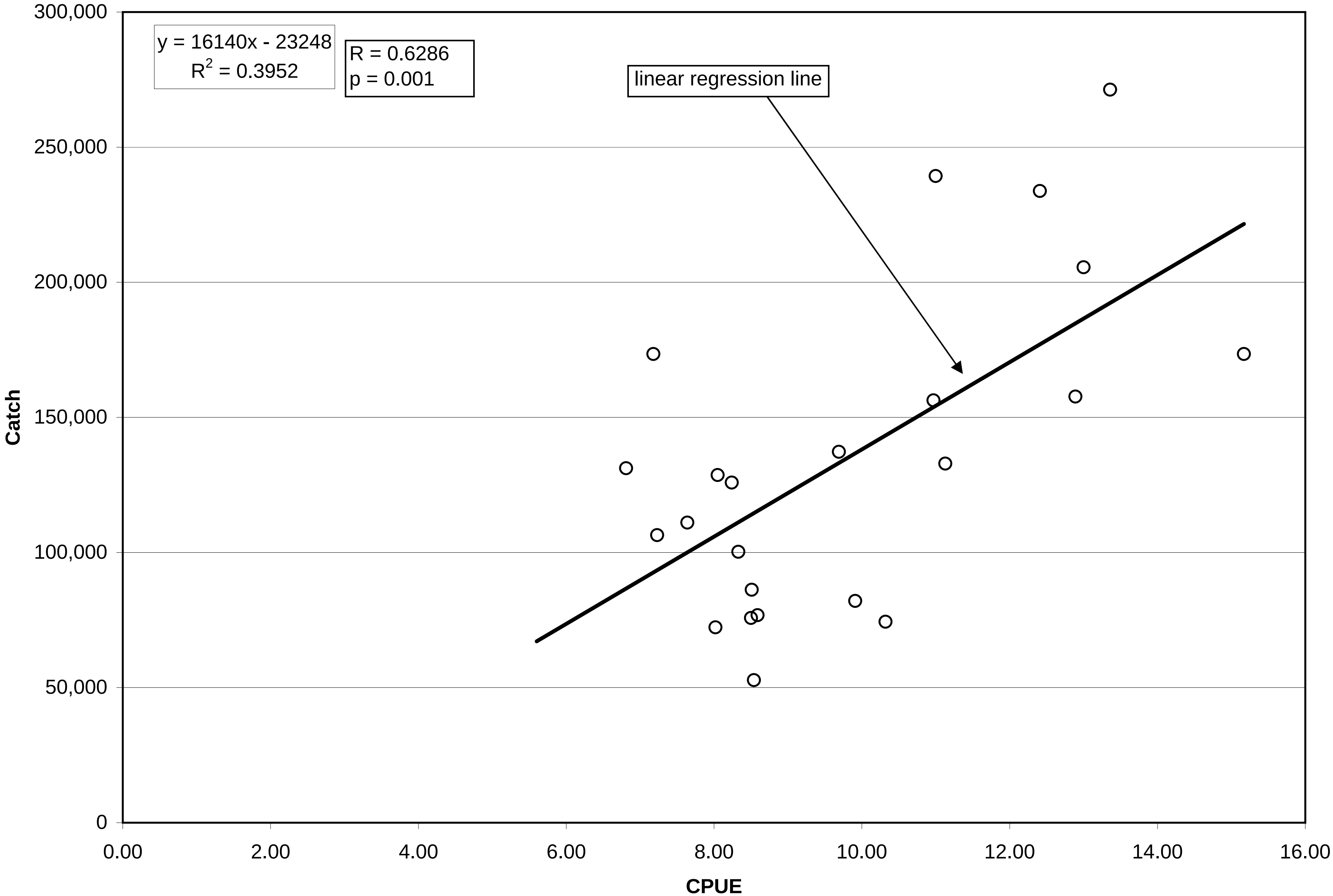

Exhibit E Plot 1

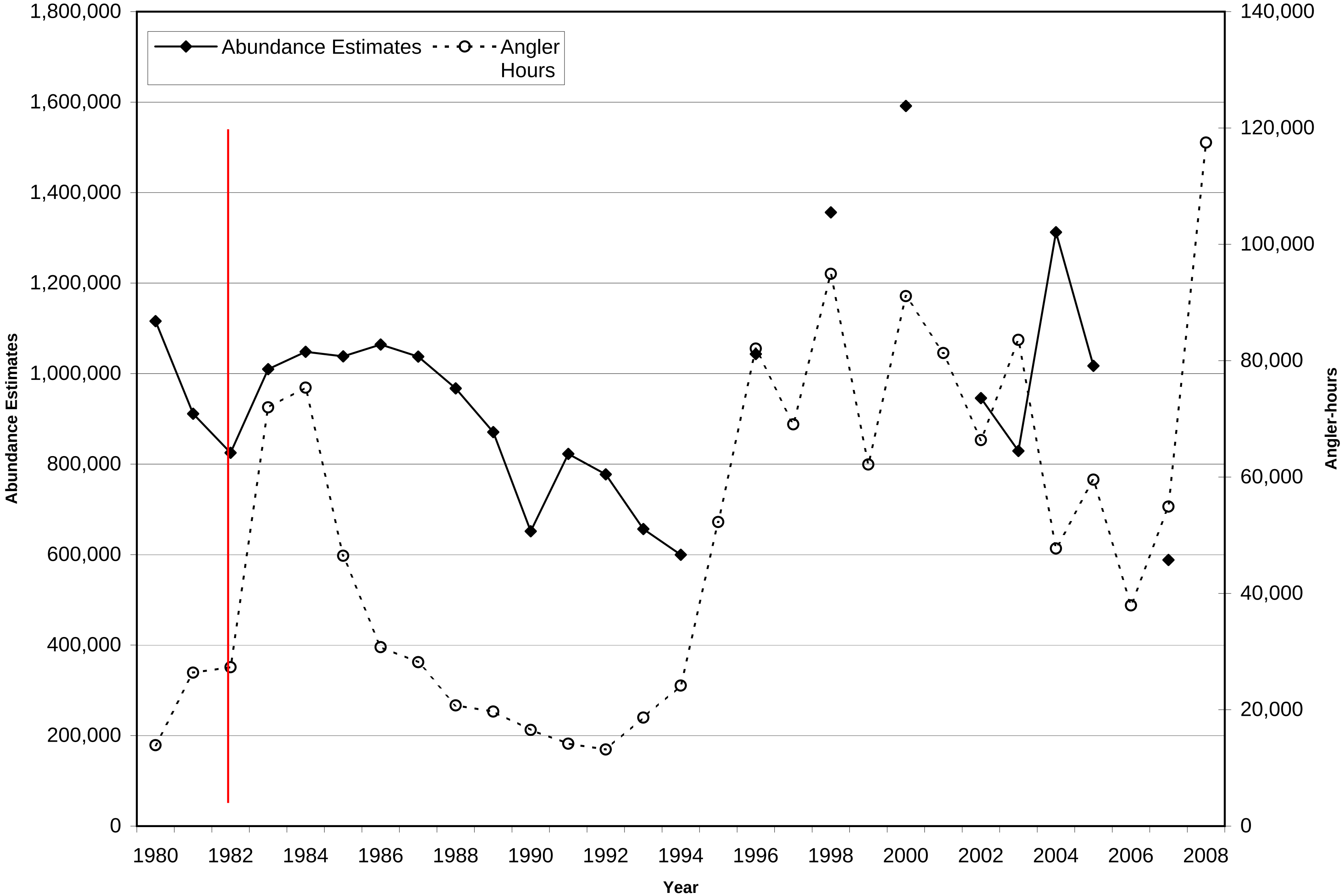

Exhibit E Plot 2

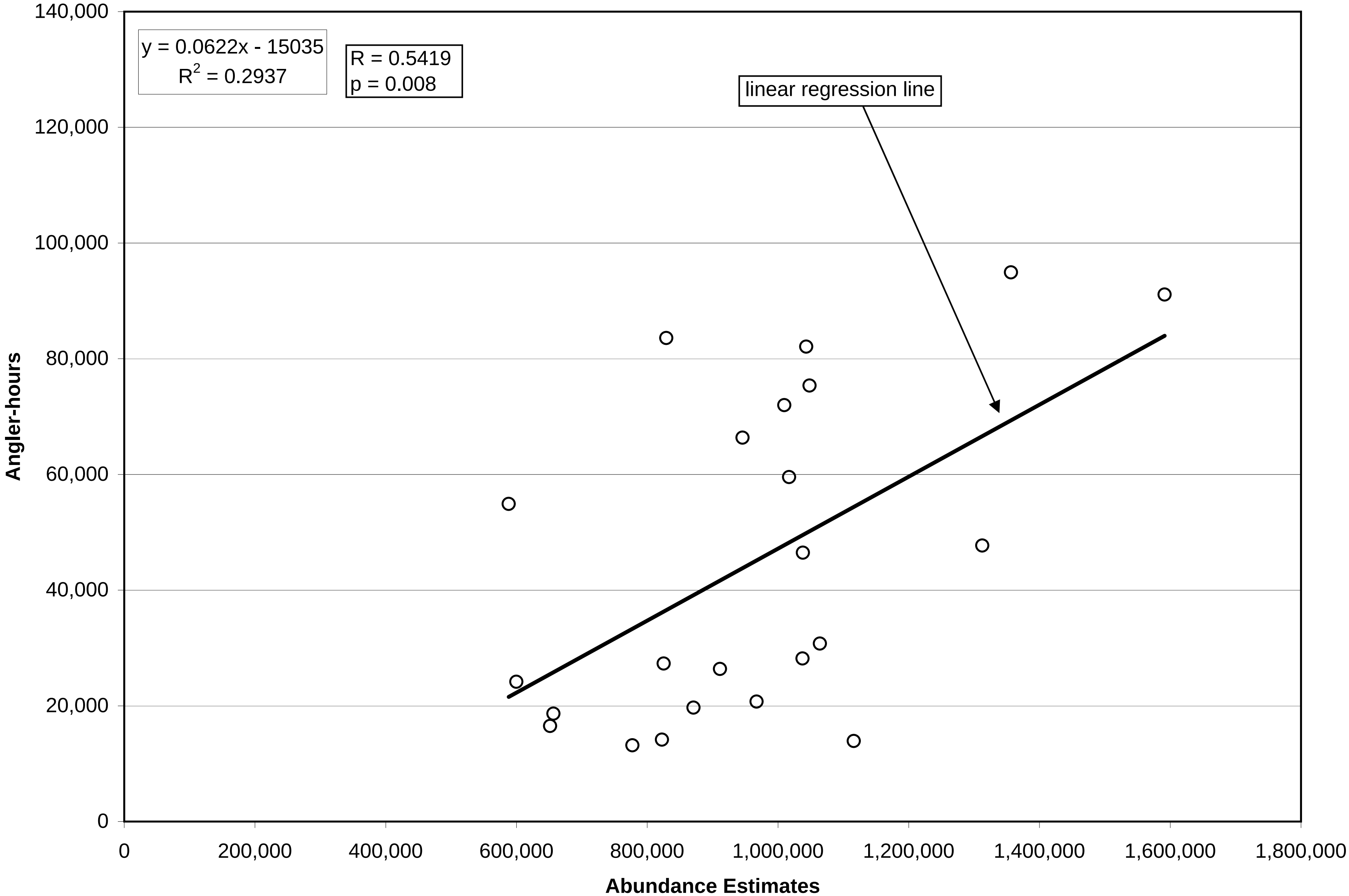

Exhibit F Plot 1

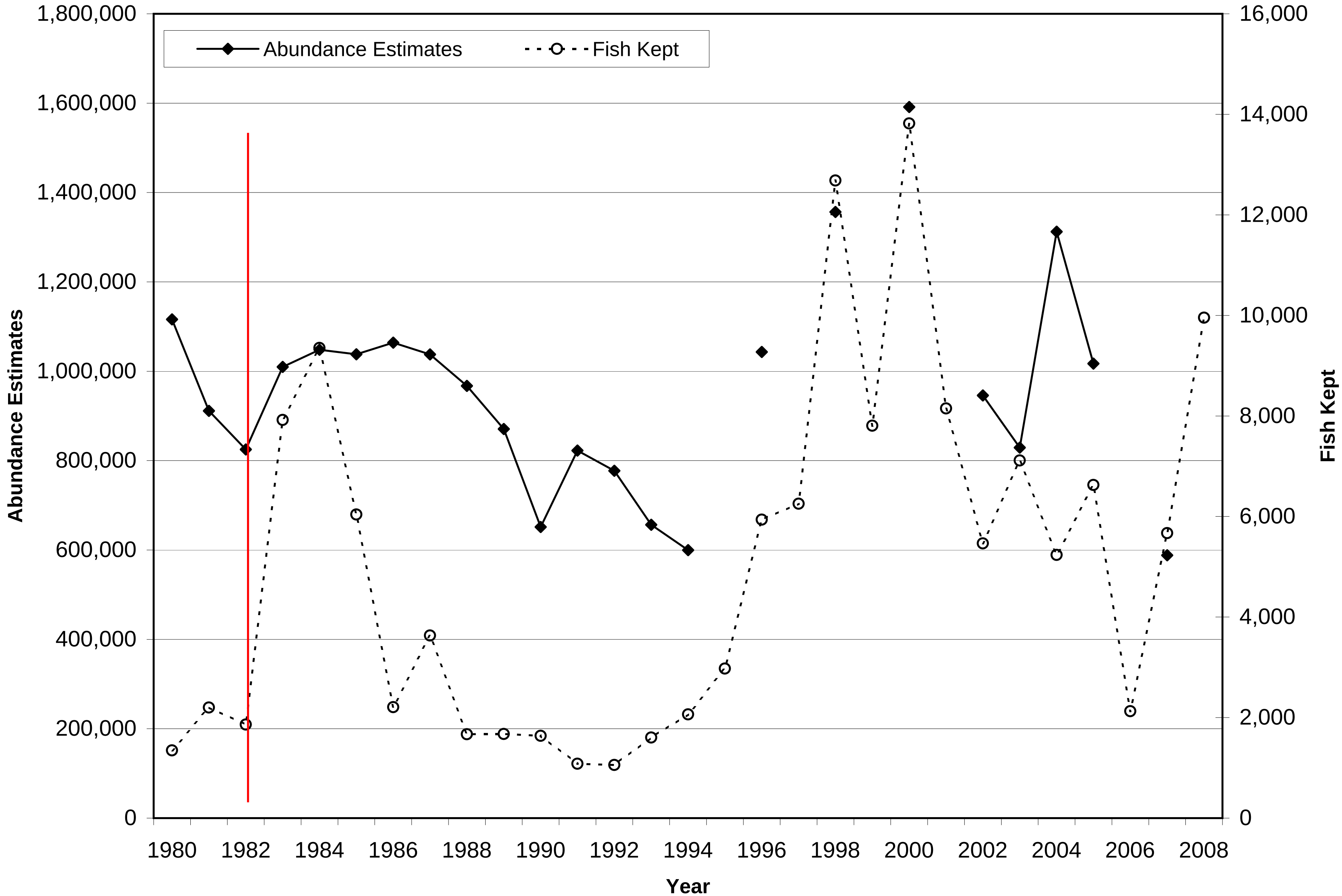

Exhibit F Plot 2