Project Termination Report
Part I: Summary

PROJECT TITLE: Economic Impacts of Private Sector Aquaculture-Based Recreational Fishing in the Western USA

REPORT GIVEN IN YEAR: 2010

PROJECT WORK PERIOD: 9/2007 – 9/2010

AUTHORS: Dr. Craig Bond and Daniel Deisenroth

PARTICIPANTS: (* indicates funded participants)

PRINCIPAL INVESTIGATOR	Dr. Craig A. Bond*	Colorado State University
CO-PRINCIPAL INVESTIGATORS	Dr. Steve Davies*	Colorado State University
	Dr. John Loomis*	Colorado State University
	Dr. Y. Hossein Farzin	University of California, Davis
	Dr. Andrew Seidl*	Colorado State University
TECHNICAL ADVISOR	Dr. Gunnar Knapp	University of Alaska, Anchorage
COLLABORATORS	Dr. Fred Conte	University of California, Davis
	Dr. John Boren	New Mexico State University
	Gary Fornshell	University of Idaho
	Dr. Kevin Fitzsimmons	University of Arizona
	Dr. Chris Myrick	Colorado State University
	Daniel Deisenroth*	Colorado State University
	Timothy Rakitan*	University of California, Davis
	Jay Griebling*	Colorado State University
PRINCIPAL INVESTIGATOR RESPONSIBLE FOR OUTREACH	Dr. Andrew Seidl*	Colorado State University
INDUSTRY ADVISORS	Ken Cline and Rebecca Cooper	
REASON FOR TERMINATION	Objectives Completed	

PROJECT OBJECTIVES

1. Collect primary data from three distinct subpopulations: Aquacultural Suppliers of Recreational Fish (ASRF), their direct customers, and recreational anglers, and prepare an economic report quantifying the magnitude and value of the economic contributions of the ASRF industry;
2. Provide an appropriate sampling frame for tracking and documenting trends over time in the ASRF industry for use in subsequent economic analyses;
3. Generate primary research about the impacts of the regulator and competitive environment on the aquaculture industry, including the relationships between private and public hatcheries, interstate trade regulations, and Native American reservation policies;
4. Develop a variety of outreach materials (including final report, peer-reviewed articles, extension, and popular press articles) and disseminate information (conferences, meetings, etc.).

PRINCIPAL ACCOMPLISHMENTS BY OBJECTIVE:

Objective 1. Collect primary data from three distinct subpopulations: Aquacultural Suppliers of Recreational Fish (ASRF), their direct customers, and recreational anglers, and prepare an economic report quantifying the magnitude and value of the economic contributions of the ASRF industry.

1A. Data Collection

Surveys were administered to ASRF producers, ASRF direct customers, and recreational anglers. All surveys were administered according to the well-respected and widely used Dillman Tailored Design Method (Dillman, 2000). 418 permit holders were identified, 245 of which indicated that they were not in business, leaving 173 potentially active ASRF producers. Of these active producers, 52 responded for a response rate of 30%. A copy of the survey and related materials can be found in appendices B-C.

The second survey was of ASRF customers, which was administered between November 2009 and January 2010. Of the 686 surveys originally mailed, 74 respondents' addresses were undeliverable and 20 responded that they were no longer operating a fishery of any type and had not stocked fish recently. Of the remaining 592 potential respondents, 260 mailed their survey back for a response rate of 44%.A copy of this survey and related materials can be found in appendices D-E.

The third survey was used to collect data from recreational anglers. 1841 anglers at 53 private and public fisheries in California and Colorado were surveyed in order to obtain the most representative sample possible. 1070 surveys were returned for a response rate of 58%. A copy of these surveys, along with region maps and cover letters, can be found in appendices F-K. Response Rates for all three surveys can be found in table 3 in appendix A.

1B. Economic Contributions of Each Surveyed Group

Using sales and expenditure data from the three surveys, two new sectors were constructed in IMPLAN input-output software, one for ASRF producers and another for ASRF customers. The production functions for these sectors map a dollar of sales of a particular product into a set of expenditures on supplies, equipment and personnel, collectively referred to as "backward linkages." Results are often reported in the form of economic multipliers. Economic multipliers indicate the magnitude of the "ripple effect" which is generated in a local or regional economy from the economic activity of one industry. An output multiplier of 1.85 for the ASRF industry, for example, means that for every $1.00 of fish sold, $1.85 of total sales or "output value" is generated in the local or regional economy.

ASRF Producers

For every dollar spent on ASRF products, $1.85 of total sales or "output value" is generated in the Western Economy. This includes the "direct effect" of ASRF producer sales (valued by definition at $1), the "indirect effect" of $.35 of sales of suppliers of inputs to ASRF producers, and the "induced effect" of $.50 of spending by employees and proprietors of ASRF firms and their suppliers. Likewise, every million dollars of ASRF sales results in 21.61 full-time jobs in the Western economy. There are a maximum of 173 ASRF producers in the Western United States, and these businesses do $53.2 million in direct recreational fish sales annually.

ASRF Customers

The average ASRF customer purchases $2,656 in ASRF products and attributes $13,593 of annual sales to the purchase of these products. An estimated 20,053 ASRF customers exist in the Western United States, purchasing $53.2 million of ASRF products and selling $272.6 million worth of recreational-fish related products to anglers in that region. Using IMPLAN software to construct a new ASRF customer industry sector, model results indicate that every dollar of ASRF customer sales

results in an additional $.79 in indirect and induced economic activity in the Western region. Every million dollars sold supports 41 full-time jobs.

Recreational Anglers

California Anglers spend an average of $180 on a typical fishing day on items such as airfare and gasoline, while Colorado anglers spend $135. The average sampled angler spends $150 per day within the Western United States. Using reported average angler expenditure at ASRF customer sites, along with estimated aggregate annual ASRF customer sales, ASRF industry-induced angler days total 6.99 million annually. Total direct ASRF-induced angler expenditures are estimated to be $1.04 billion annually in the Western region. IMPLAN software is used to estimate that every dollar of Angler expenditures leads to an additional $.83 of economic activity in the region. Every million dollars of angler expenditures support 36 full-time jobs.

Forward Linkages and Total Economic Contribution

Accounting for the multiplier effect of ASRF-induced angler expenditures yields a total of $1.913 billion in annual expenditures in the Western Region. The multiplier effect of ASRF-induced angler expenditures results in 26,229 full-time jobs in the Western United States. These economic contributions are rooted in the 53.2 million in ASRF direct sales, implying that every dollar of ASRF producer sales leads to $35.92 in annual within-region output. By the same logic, every million dollars of ASRF sales supports 493 full-time jobs in the Western United States. With most of the producers concentrated in California, Colorado, Oregon, Utah and Washington, the geographic distribution of the ASRF industry's impact is not uniform. Nearly half of the total economic contribution of the ASRF industry accrues within California.

Although Alaskan hatcheries are excluded from the analysis of for-profit recreation-based aquaculture industry, secondary data is used to estimate the economic contribution of the not-for profit recreation-based aquaculture industry in that state. The heavily regulated Alaskan salmon enhancement program contributed roughly 345,564 additional fish to the sport fishery harvest in 2008, resulting in an economic contribution of $184 million of output and 1814 jobs in the Alaskan economy during that year.

Objective 2: Provide an appropriate sampling frame for tracking and documenting trends over time in the ASRF Industry for use in subsequent economic analyses.

In order to track and document trends over time in the ASRF industry, it is necessary to collect data from three distinct subgroups: ASRF producers, their direct customers and recreational anglers.

The CSU team compiled relevant information regarding all active ASRF permit holders in the Western United States. There are currently no more than 173 potential ASRF producers identified in the Western United States. Numbers of producers in each state is summarized in table 1 in appendix A.

A list of 686 direct customers to the ASRF industry was identified in Colorado. These customers encompass all potential types of ASRF customers including municipalities, private ranches and clubs, homeowners' associations, and other private property.

A sampling frame with 53 policy relevant recreational angling sites was created, and 1841 recreational anglers in both California and Colorado were surveyed.

Objective 3: Generate primary research about the impacts of the regulator and competitive environment on the aquaculture industry, including the relationships between private and public hatcheries, interstate trade regulations, and Native American reservation policies.

One identified area of research is the nature of the regulatory structure of the ASRF industry, especially as the regulators tend to be production competitors. From an economic standpoint, this is an extremely unusual structure, which likely leads to incentives that may not be in line with maximization

of social welfare. The team intends to explore this relationship in a theoretical paper that will document the various incentives that result from this structure.

A second identified area of research is the potential to account for substitution patterns among anglers that would occur in the absence of the ASRF industry. Current state-of-the-art models of economic activity fail to account for close substitutes in consumption among end-users of a particular product. Researchers at CSU will continue to develop models to capture this substitution over the next year.

A third identified area of research is the potential to account for bioeconomic feedback loops in recreational fish stocking. Fish stocking augments fish population and fishery quality, thereby encouraging angler visitation. However, this angler visitation leads to more fish harvest and lower fishery quality. Accounting for these feedback loops will help future researchers evaluate the benefits and costs of recreational fish stocking. Research along this thread has already been presented at the Agricultural and Applied Economics Association Annual Meetings in Denver, Colorado in July, 2010, and will continue to be developed throughout the next year.

Objective 4: Develop a variety of outreach materials (including final report, peer-reviewed articles, extension, and popular press articles) and disseminate information (conferences, meetings, etc…).

In order to inform producers, their customers, and recreational anglers about the nature of the project and the reasons for collecting the data, three FAQ websites about the project were created, one for each surveyed group, respectively. In addition to these websites, 10 presentations about the economic contribution of the ASRF industry have been given to various associations in the West. Furthermore, 10 extension articles and one economic development report have been authored in order to broaden the audience which is exposed to the results of this study (see Appendix M for samples). Finally, researchers at CSU are currently finalizing an economic study for submission to the *Journal of Aquaculture Economics*. Research over the next year will address angler substitution patterns and fishery bioeconomic feedback loops, and additional manuscripts will be prepared for submission to various peer-reviewed journals. The extension efforts will continue with finalization of the Final Economic Report, preparation and distribution of a multi-page glossy summary of results from the study, and presentations where invited and appropriate.

IMPACTS:

Relevance: While most people are aware of federal and state fish stocking agencies such as the USFWS or state-level fish and game departments, few are aware of the private aquaculture businesses which grow fish used for stocking in both private and public fisheries. These businesses grow and sell fish for stocking thousands of bodies of water in the Western United States, including municipal, county, and state public waters, private fishing clubs and dude ranches, fee fishing ponds, and private land. Fisheries stocked with ASRF-produced fish supplement fishing opportunities offered by state and federal fisheries. The stocking of fish in public and private waters undoubtedly encourages tourism, which in turn stimulates the economies of the rural communities adjacent to these waters.

Response: In 2006, with producer support, the Western Regional Aquaculture Center sponsored a project to assess the economic contribution of the Aquacultural Suppliers of Recreational Fish (ASRF). The objectives of the report were to develop a sampling frame for the industry, its direct customers, and anglers, to document the economic contribution of that industry, and to develop a set of outreach materials to educate the public about this topic.

Results: Throughout 2008-2009, surveys were distributed to all ASRF producers, 686 of their direct customers and 1841 recreational anglers in the Western United States. Using IMPLAN input-output models, the economic contribution of the ASRF industry, while accounting for both forward and

backward linkages, is estimated to be $1.91 billion dollars and is estimated to support 26,229 jobs annually in the Western United States. Every dollar of ASRF sales results in a multiplier effect of $35.92 dollars generated in the region, and every million dollars of ASRF sales results in 493 full-time jobs.

Impact: This information will ultimately benefit ASRF producers by acting as an educational tool for the general public and for regulatory agencies. As a result, policy decisions may be impartial and thus potentially more favorable than past legislation which was made without the aforementioned information at hand.

Collaborators: Faculty at Colorado State University, University of Arizona, University of California, Davis, University of Idaho, and New Mexico State University, along with Cline Trout Farms, Liley Fisheries and E & J Fish Farms.

Contact: Dr. Craig A. Bond Department of Agricultural and Resource Economics Colorado State University Fort Collins, CO 80523-1172, Craig.Bond@Colostate.edu, (970) 491-6951.

RECOMMENDED FOLLOW-UP ACTIVITIES:

There are three primary areas of research which could prove valuable to ASRF Producers:

1. Waters which are privately stocked by homeowners' associations (HOA) are likely to increase the home value of HOA members. Research documenting the magnitude of this value has not been undertaken, and the estimates in this study do not capture this additional value to homeowners. A primary concern of WRAC stakeholders should be to address this gap in the literature.
2. Another interesting thread of research incorporates net economic value, rather than the economic activity supported by the ASRF industry. Net economic value is the difference between what an angler would be willing to pay for a fishing trip minus the amount that he or she actually pays. As most recreational fishing studies have evaluated net economic value, comparison of net economic value between private and public fisheries in a similar region may lend insight into the formation of policies which could affect the ASRF industry in a positive manner.
3. The Alaskan non-profit salmon enhancement program is primarily intended to augment commercial fish harvests. However, stocked fish that are not harvested by commercial fishermen in fact augment *sport* fishing catch rates, thereby encouraging tourism and promoting economic activity in Alaska. While this study uses secondary analysis to estimate the economic contribution of hatchery-reared, sport-harvested fishing in Alaska, a more thorough investigation of the linkages between the Alaska aquaculture industry and recreation-based economic contributions would prove valuable to any policymaker interested in the health of the Alaskan economy.

SUPPORT:

Year	WRAC-USDA Funding	Other Support					Total Support
		University	Industry	Other Federal	Other	Total	
Year 1 (FY'08)	$98,644	N/A	N/A	N/A	N/A	N/A	$98,644
Year 2 (FY'09)	$99,624	N/A	N/A	$60,000	$15,000	N/A	$174,624
Total	$198,268	N/A	N/A	$60,000	$15,000	N/A	$273,268

PUBLICATIONS, MANUSCRIPTS, AND PAPERS PRESENTED:

Publications in Print:

Deisenroth, D.B. and C.A. Bond (2010a) "The Economic Contribution of the Private, Recreation-Based Aquaculture Industry in the Western United States" Final Report to the Western Regional Aquaculture Center

Deisenroth, D.B. and C.A. Bond (2010b) "A Brief Look at the Customers of the Aquacultural Suppliers of Recreational Fish" *The Fishline* 22,3

Deisenroth, D.B. and C.A. Bond (2010c) "Progress Report: The Economic Contribution of the Private Recreation-Based Aquaculture Industry in the Western United States" *The Fishline* 22,1

Deisenroth, D.B. and C.A. Bond (2010d) "The Aquacultural Suppliers of Recreational Fish (ASRF): A Look at the Freshwater Recreational Fish Industry in the Western United States" *Department of Agricultural and Resource Economics Economic Development Report*, 3-1, pp.1-11 http://dare.colostate.edu/pubs/edr10-01.pdf

Deisenroth, D.B. and C.A. Bond (2010e) "The Total Economic Contribution of the Private, Recreation-Based Aquaculture Industry in the Western United States" *The Fishline* 22,4

Deisenroth, D.B. and C.A. Bond (2009a) "Combining Information from Private Aquaculture Facilities, Private Fisheries, and Anglers to Estimate the Economic Contribution of the Aquacultural Suppliers of Recreational Fish" *The Fishline* 21,4

Deisenroth, D.B. and C.A. Bond (2009b) "Moving Forward With the Economic Contribution of the Aquacultural Suppliers of Recreational Fish" *The Fishline* 21,3

Deisenroth, D.B. and C.A. Bond (2009c) "Update: Estimating the Economic Contribution of the Aquacultural Suppliers of Recreational Fish (ASRF) in the Western U.S." *The Fishline* 21,2

Deisenroth, D.B. and C.A. Bond (2009d) "Update: Estimating the Economic Contribution of the Aquacultural Suppliers of Recreational Fish (ASRF) in the Western United States" *The Fishline* 21,1

Bond, C.A. and D.B. Deisenroth (2008a) "Estimating the Economic Impacts of the Aquacultural Suppliers of Recreational Fish" *Waterlines* http://www.fish.washington.edu/wrac/

Bond, C.A. and D.B. Deisenroth (2008b) "Phase One of Colorado State University Study on the Economic Impacts of the Aquacultural Suppliers of Recreational Fish Nearing Completion" *The Fishline* 20,4

Bond, C.A. and D.B. Deisenroth (2008c) "The Economic Impacts of the Aquacultural Suppliers of Recreational Fish Phase One Nearing Completion" *The Fishline* 20,3

Bond, C.A. and D.B. Deisenroth (2007) "Colorado State University to Lead Effort to Quantify Economic Contribution of Recreational Fish Producers" *The Fishline* 19,4

Websites:

Deisenroth, D.B. and C.A. Bond (2009) "Angler Survey Frequently Asked Questions" http://dare.agsci.colostate.edu/csuagecon/anglersurvey .

Deisenroth, D.B. and C.A. Bond (2009) "Privately Stocked Fishery Survey Frequently Asked Questions" http://dare.agsci.colostate.edu/csuagecon/privatefisheryimpact.aspx

Bond, C.A. and Deisenroth, C.B. (2008) "The Economic Contributions of the Suppliers of Recreational Fish: Frequently Asked Questions" http://dare.agsci.colostate.edu/csuagecon/wracimpact.htm ,

Manuscripts:

Deisenroth, D.B. (2010) "Incorporating Complex Spatial Substitution Patterns and Bioeconomic Feedback Loops Into The Valuation of a Renewable Natural Resource: The Case of a Recreational Fishery" Ph.D. Dissertation, In Preparation

Deisenroth, D.B. and C.A. Bond (2010a) "Accounting for Backward and Forward Linkages to Estimate the Economic Contribution of the Private Recreation-Based Aquaculture Industry in the Western United States" In Preparation
Deisenroth, D.B., C.A. Bond and J.B. Loomis (2010) "Combining Information from the Random Utility Model with Input Output Models in Order to Account for Substitution Effects: The Case of a Recreational Fishery" In Preparation
Deisenroth, D.B. and C.A. Bond (2010b) "The Economic Significance of Bioeconomic Feedback Loops: Incorporating Complex Spatial Substitution Patterns Into the Optimal Management of a Recreational Fishery"In Preparation

Papers Presented:
Deisenroth, D. (November 2010) "Combining Information from the Random Utility Model with Input-Output Models in Order to Account for Substitution Effects: The Case of a Recreational Fishery" *Accepted presentation at the North American Regional Science Council Annual Meeting*, Denver, Colorado
Deisenroth, D. (September 2010) "The Economic Contribution of the Private, Recreation-Based Aquaculture Industry in the Western United States" *Presented at the United States Trout Farmers' Association and National Association of State Aquaculture Coordinators joint annual meeting,* Branson, Missouri
Deisenroth, D. (April 2010) "The Economic Significance of Bioeconomic Feedback Loops: The Case of a Recreational Fishery" *Presented by Daniel Deisenroth at the Department of Agricultural and Resource Economics Lunch Seminar Series,* Fort Collins, Colorado. Also p*resented as a poster at the Agricultural and Applied Economics Association annual meetings*, Denver, Colorado (July 2010).
Bond, C. and D. Deisenroth (March 2010) "Aquaculture and Stocking Recreational Water in the West: A Socioeconomic Assessment" *Presented at the California Aquaculture Association Special Session,* San Diego, California
Deisenroth, D. (February, 2010) "A Bioeconomic Approach to Capturing the Economic Value and Economic Contribution of Fish Stocking in Colorado Waters" *Presented at the Departments of Agricultural and Resource Economics and Economics Graduate Student Symposium,* Fort Collins, Colorado
Deisenroth, D. (January, 2010) "The Economic Contribution of Private Sector Aquaculture-Based Recreational Fishing in the Western USA- Research Project Update" *Presented at the Colorado Aquaculture Association annual meetings,* Mount Princeton, Colorado
Bond, C. (October 2009) "Economic Impacts of Private Sector Aquaculture-Based Recreational Fishing in the Western USA" *Presented at the Western Regional Aquaculture Center IAC/TC Annual Meeting*, Spokane, Washington
Deisenroth, D. (June, 2009) "The Economic Contribution of the Aquacultural Suppliers of Recreational Fish in The Western United States" *Presented at the Western Agricultural Economics Association annual meetings*, Lihue, Hawaii *Also presented at the Western Division of the American Fisheries Society Student Colloquium,* Fort Collins, Colorado (October 2009)
Deisenroth, D. (January 2009) "A Preliminary Look at the Aquacultural Suppliers of Recreational Fish in The Western United States" *Presented at the Colorado Aquaculture Association annual meetings,* Mount Princeton, Colorado

Project Termination Report
Part II: Detail

PROJECT TITLE: Economic Impacts of Private Sector Aquaculture-Based Recreational Fishing in the Western USA

REPORT GIVEN IN YEAR: 2010

PROJECT WORK PERIOD: 9/2007 – 9/2010

AUTHORS: Dr. Craig Bond and Daniel Deisenroth

PARTICIPANTS: (* indicates funded participants)

PRINCIPAL INVESTIGATOR	Dr. Craig A. Bond*	Colorado State University
CO-PRINCIPAL INVESTIGATORS	Dr. Steve Davies*	Colorado State University
	Dr. John Loomis*	Colorado State University
	Dr. Y. Hossein Farzin	University of California, Davis
	Dr. Andrew Seidl*	Colorado State University
TECHNICAL ADVISOR	Dr. Gunnar Knapp	University of Alaska, Anchorage
COLLABORATORS	Dr. Fred Conte	University of California, Davis
	Dr. John Boren	New Mexico State University
	Gary Fornshell	University of Idaho
	Dr. Kevin Fitzsimmons	University of Arizona
	Dr. Chris Myrick	Colorado State University
	Daniel Deisenroth*	Colorado State University
	Timothy Rakitan*	University of California, Davis
	Jay Griebling*	Colorado State University
PRINCIPAL INVESTIGATOR RESPONSIBLE FOR OUTREACH	Dr. Andrew Seidl*	Colorado State University
INDUSTRY ADVISORS	Ken Cline and Rebecca Cooper	
REASON FOR TERMINATION	Objectives Completed	

PROJECT OBJECTIVES

1. Collect primary data from three distinct subpopulations: Aquacultural Suppliers of Recreational Fish (ASRF), their direct customers, and recreational anglers, and prepare an economic report quantifying the magnitude and value of the economic contributions of the ASRF industry;
2. Provide an appropriate sampling frame for tracking and documenting trends over time in the ASRF industry for use in subsequent economic analyses;
3. Generate primary research about the impacts of the regulator and competitive environment on the aquaculture industry, including the relationships between private and public hatcheries, interstate trade regulations, and Native American reservation policies;
4. Develop a variety of outreach materials (including final report, peer-reviewed articles, extension, and popular press articles) and disseminate information (conferences, meetings, etc.).

5. TECHNICAL SUMMARY AND ANALYSIS

Deisenroth and Bond (2010a, Appendix A) summarize the backward and forward linkages and total economic contribution of the private, recreation-based aquaculture industry in the Western United States. For every dollar of recreation-based aquaculture sales, $35.92 dollars is generated in the region. For every million dollars of sales, 493 full-time jobs are created in the region. The presence of the industry results in a total economic contribution of $1.91 billion annually, and supports 26,229 full-time jobs in the Western Region. An *additional* $184 million of output and 1,814 jobs are supported by the sport harvest of fish produced through the Alaskan non-profit salmon enhancement program.

Objective 1. Collect primary data from three distinct subpopulations: Aquacultural Suppliers of Recreational Fish (ASRF), their direct customers, and recreational anglers, and prepare an economic report quantifying the magnitude and value of the economic contributions of the ASRF industry.

1A. Data Collection

Surveys were administered to ASRF producers, ASRF direct customers, and recreational anglers. All surveys were administered according to the well-respected and widely used Dillman Tailored Design Method (Dillman, 2000). The first survey instrument was created in order to collect data from the ASRF industry. The survey was constructed on the basis of previous surveys which were used for research which quantified the economic contribution of other industries. The ASRF survey, of course, catered to the specific needs of this study and to the details of the ASRF industry. Sections in the survey address operational information (i.e. operation type, production technology), sales information, cost information, and business information (i.e. demographics, income). The survey was administered between January, 2008 and January, 2009. To date, 418 permit holders have been identified, 245 of which indicated that they were not in business, leaving 173 potentially active ASRF producers. Of these active producers, 52 responded for a response rate of 30%. A copy of the survey and related materials can be found in appendices B-C.

The second survey was of ASRF customers, which was administered between November 2009 and January 2010. This survey asks privately stocked fishery operators about operational information, sales, expenditures, and business information. Of the 686 surveys originally mailed, 74 respondents' addresses were undeliverable and 20 responded that they were no longer operating a fishery of any type and had not stocked fish recently. Of the remaining 592 potential respondents, 260 mailed their survey back for a response rate of 44%.A copy of this survey and related materials can be found in appendices D-E.

The third survey was used to collect data from recreational anglers. The survey was constructed on the basis of previous surveys which were used for research which estimated the economic benefits and economic contributions of outdoor recreation. This survey, of course, was catered to the specific needs of this study and to the details of the recreational anglers. Sections in the survey address general fishing trip information, information about trip substitution possibilities, expenditure information, and demographics. During the summer and fall of 2009, anglers at 53 private and public fisheries in California and Colorado were surveyed in order to obtain the most representative sample possible. Surveys were distributed to 873 public fishery anglers and 355 private fishery anglers in Colorado (by the CSU Research Team), with 489 respondents to the public survey and 222 respondents to the private survey for an overall response rate of 58%. An additional 613 surveys were distributed to California (by the UC Davis Research Team) public sites, with 359 surveys returned for a response rate of 58.5%. There are separate surveys for California

and Colorado. A copy of these surveys, along with region maps and cover letters, can be found in appendices F-K. Response Rates for all three surveys can be found in table 3 in appendix A.

1B. Summary Statistics and Economic Contributions of Each Surveyed Group

Using sales and expenditure data from the three surveys, two new sectors are constructed in IMPLAN input-output software, one for ASRF producers and another for ASRF customers. The production functions for these sectors map a dollar of sales of a particular product into a set of expenditures on supplies, equipment and personnel, collectively referred to as "backward linkages." Results are often reported in the form of economic multipliers. Economic multipliers indicate the magnitude of the "ripple effect" which is generated in a local or regional economy from the economic activity of one industry. An output multiplier of 1.85 for the ASRF industry, for example, means that for every $1.00 of fish sold, $1.85 is generated in the local or regional economy. Employment multipliers indicate the amount of jobs that are generated in a local or regional economy for every one job generated in the ASRF industry.

Multipliers are composed of three effects: the direct effect, the indirect effect, and the induced effect. Direct effects come directly (and only) from the industry of analysis. For example, for every dollar spent on ASRF products, only one dollar of economic activity is directly attributable to the ASRF industry. Indirect effects come from the fact that ASRF producers spend money on items such as fish feed, trucks, gasoline, etc. The businesses which supply inputs to the ASRF industry also benefit from ASRF production. Finally, the induced effect comes from the fact that employees spend their wages on various things in their local or regional economy. All of these effects are combined to form the Type SAM (Social Accounting Matrix) multiplier.

ASRF Producers

A typical ASRF business is operated by a 55-year old married man who has been in the business over 20 years. Gross sales for ASRF businesses average $330,000 annually (although sales are much higher for a few businesses but lower for a majority of businesses). Finally, income from aquaculture typically constitutes about half of household income, with many producers indicating through phone conversations that they are involved in some other agricultural activity for supplemental income.

Of the $330,000 in gross annual recreational fish sales by ASRF producers, $120,000 goes towards non-depreciated expenditures such as fish and eggs, feed, electricity, and gasoline. Labor expenditures just exceed $90,000 annually, including wages, benefits and labor taxes. $75,000 is spent annually on the purchase, maintenance and lease of buildings, fish production facilities, equipment and transportation equipment. Finally, proprietors net only $45,000 annually. This makes sense, given that the average ASRF producer only derives 50% of his annual income from his ASRF operation.

IMPLAN software is used to trace through the backward linkages of ASRF expenditures to generate economic multipliers. For every dollar spent on ASRF products, $1.85 is generated in the Western Economy. This is due to the direct effect of the $1 to ASRF producers, the indirect effect of $.35 to input suppliers, and the induced effect of $.50 of spending by employees and proprietors. Likewise, every million dollars of ASRF sales results in 21.61 full-time jobs in the Western economy. There are a maximum of 173 ASRF producers in the Western United States, and these businesses are estimated to do $53.2 million in direct recreational fish sales annually.

ASRF Customers

ASRF customers come in many forms, including private backyard ponds, private dude ranches, private fishing clubs, homeowners' associations, fee-fishing operations, and public waters. 50% of surveyed ASRF customers are private ponds. The remaining 50% is divided between private dude ranches and fishing clubs, fee-fishing ponds and homeowners' associations.

The average ASRF customer purchases $2,656 in ASRF products and attributes $13,593 of annual sales to the purchase of these products. An estimated 20,053 ASRF customers exist in the Western United States, purchasing $53.2 million of ASRF products and selling $272.6 million worth of recreational-fish related products to anglers in that region. Using IMPLAN input-output software to construct a new ASRF customer industry sector, model results indicate that every dollar of ASRF customer sales results in an additional $.79 in indirect and induced economic activity in the Western region. Every million dollars sold supports 41 full-time jobs.

Recreational Anglers

The survey of anglers suggests that those intercepted at private fisheries are older, more likely to be retired, and receive a higher income than their public fishery counterparts. The average age of anglers at private fisheries is just over 60, compared with 53 and 50 for Colorado public and California public anglers, respectively. Anglers at private fisheries also have an average of 15.77 years of education (a 4-year bachelor's degree is 16 years), compared with 14.8 and 14.2 for Colorado and California public fishery anglers, respectively. Most of the private fishery anglers surveyed are members of a private fishing club, with only small percentages of public fishery anglers being members. Most anglers at all types of site are male.

California Anglers spend an average of $180 on a typical fishing day on items such as airfare and gasoline, while Colorado anglers spend $135. The average sampled angler spends $150 per day within the Western United States. Using reported average angler expenditure at ASRF customer sites, along with estimated aggregate annual ASRF customer sales, ASRF industry-induced angler days are estimated to total 6.99 million annually. Using average angler expenditure data, total direct ASRF-induced angler expenditures are estimated to be $1.04 Billion annually in the Western region. IMPLAN software is used to estimate that every dollar of Angler expenditures leads to an additional $.83 of economic activity in the region. Every million dollars of angler expenditures support 36 full-time jobs.

1C. Forward Linkages and Total Economic Contribution

Accounting for the multiplier effect of ASRF-induced angler expenditures yields a total of $1,913,000,000 in annual expenditures in the Western Region. The multiplier effect of ASRF-induced angler expenditures results in 26,229 full-time jobs in the Western United States. These economic contributions are rooted in the 53.2 million in ASRF direct sales, implying that every dollar of ASRF producer sales leads to $35.92 in annual within-region output. By the same logic, every million dollars of ASRF sales supports 493 full-time jobs in the Western United States. With most of the producers concentrated in California, Colorado, Oregon, Utah and Washington, the geographic distribution of the ASRF industry's impact is not uniform. Nearly half of the total economic contribution of the ASRF industry accrues within California.

Although Alaskan hatcheries are excluded from the analysis of for-profit recreation-based aquaculture industry, secondary data is used to estimate the economic contribution of the not-for profit recreation-based aquaculture industry in that state. The heavily regulated Alaskan salmon enhancement program contributed roughly 345,564 additional fish to the sport fishery harvest in 2008, resulting in an economic contribution of $184 million of output and 1814 jobs in the Alaskan economy during that year.

Objective 2. Provide an appropriate sampling frame for tracking and documenting trends over time in the ASRF industry for use in subsequent economic analyses.

In order to track and document trends over time in the ASRF industry, it is necessary to collect data from three distinct subgroups: ASRF producers, their direct customers and recreational anglers. The reason for this is that changes in the behavior or regulations on direct customers or recreational anglers will have a direct effect on the success of the ASRF industry.

First, relevant information regarding all ASRF permit holders in the Western United States was compiled. There are many permit holders in the Western United States who are not actually in business, either because they have stopped production or because they simply do not sell recreational fish. These businesses were obviously removed from the final list. There are currently no more than 173 potential ASRF producers identified in the Western United States. Most ASRF producers are concentrated in California, Colorado, Washington, and Oregon, with very few producers in New Mexico and Arizona, and none in Alaska. Finfish farming is illegal under Alaska Statute 16.40.210 unless farmed by a non-profit ocean-based Salmon ranch. More detail on the Alaskan fishery enhancement program can be found in appendix L. A list of WRAC states and the number of active producers in each state, along with information sources, can be found in table 1 in Appendix A.

Second, a list of 686 direct customers to the ASRF industry was identified in Colorado. These customers encompass all potential types of ASRF customers including municipalities, private ranches and clubs, homeowners' associations, and other private property. Although it would have been ideal to have a list of all potential customers of the private aquaculture industry, unfortunately since a large portion of these customers are private pond owners, no publicly-available lists of these customers are readily available. Instead, several Colorado aquaculture producers, including Cline Trout Farms, Liley Fisheries and E & J Fish Farms, helped to compile a list of 686 of their customers. Colorado contains a wide diversity of potential ASRF customers and given the relationships with industry advisors and the Colorado Aquaculture Association, we believe that this state offers a quality outlet from which to sample ASRF customers. Furthermore, no other state afforded this opportunity to the study.

Finally, a sampling frame was created which includes 53 policy relevant recreational angling sites, along with 1841 recreational anglers in both California and Colorado. All of the aforementioned individuals have been surveyed. In both states, all sites fall within a region of analysis which was identified by several key features: 1) The presence of many types of recreational fisheries, including private and public ponds, lakes, reservoirs, streams, and rivers. This also includes private ranches, private fishing clubs, municipalities, and homeowner's associations. 2) The regions are small enough that an angler could potentially substitute to almost any other fishery within the region in the absence of his preferred fishery. 3) The regions are large enough to be adjacent to both large population centers and rural areas in order to provide the most generalizable depiction of the economic effects of the ASRF industry. Collecting data from anglers at many different types of sites allows for identification of substitution patterns by anglers across fisheries (e.g. from private to public sites) that may occur in the absence of the ASRF industry in order to better assess the effect that changes in ASRF production levels has on recreational anglers' economic activity. Appendices F-K give details on the Angler survey regions of analysis as well as sites from which data was collected.

Objective 3. Generate primary research about the impacts of the regulator and competitive environment on the aquaculture industry, including the relationships between private and public hatcheries, interstate trade regulations, and Native American reservation policies.

One identified area of research is the nature of the regulatory structure of the ASRF industry, especially as the regulators tend to be production competitors. From an economic standpoint, this is an extremely unusual structure, which likely leads to incentives that may not be in line with maximization of social welfare. The team intends to explore this relationship in a theoretical paper that will document the various incentives that result from this structure.

A second identified area of research is the potential to account for substitution patterns among anglers that would occur in the absence of the ASRF industry. Current state-of-the-art models of economic activity fail to account for close substitutes in consumption among end-users of a particular product. Researchers at CSU will continue to develop models to capture this substitution over the next year.

A third identified area of research is the potential to account for bioeconomic feedback loops in recreational fish stocking. Fish stocking augments fish population and fishery quality, thereby encouraging angler visitation. However, this angler visitation leads to more fish harvest and lower fishery quality. Accounting for these feedback loops will help future researchers evaluate the benefits and costs of recreational fish stocking. Research along this thread has already been presented at the Agricultural and Applied Economics Association Annual Meetings in Denver, Colorado in July, 2010, and will continue to be developed throughout the next year.

Objective 4. Develop a variety of outreach materials (including final report, peer-reviewed articles, extension, and popular press articles) and disseminate information (conferences, meetings, etc…).

In order to inform producers, their customers, and recreational anglers about the nature of the project and the reasons for collecting the data, three FAQ websites about the project were created, one for each surveyed group, respectively. In addition to these websites, 10 presentations about the economic contribution of the ASRF industry have been given to various associations including the Colorado Aquaculture Association, the Western Agricultural Economics Association, the American Fisheries Society, the American Applied Economics Association, the US Trout Farmers' Association and the National Association of State Aquaculture Coordinators by Daniel Deisenroth and to the California Aquaculture Association and Western Regional Aquaculture Center by Craig Bond. Furthermore, 10 extension articles have been authored by Craig Bond and Daniel Deisenroth in *The Fishline* (published by the CO Aquaculture Association) and *Waterlines* (published by WRAC) and one economic development report in order to broaden the audience which is exposed to the results of this study. Finally, researchers at CSU are currently finalizing an economic study for submission to the *Journal of Aquaculture Economics* and research over the next year will address angler substitution patterns and fishery bioeconomic feedback loops will be prepared for submission to various peer-reviewed journals.

IMPACTS:

Relevance: While most people are aware of federal and state fish stocking agencies such as the USFWS or state-level fish and game departments, few are aware of the private aquaculture businesses which grow fish used for stocking in both private and public fisheries. These businesses grow and sell fish for stocking thousands of bodies of water in the Western United States, including municipal, county, and state public waters, private fishing clubs and dude ranches, fee fishing ponds, and private land. Fisheries stocked with ASRF-produced fish supplement fishing opportunities offered by state and federal fisheries. The stocking of fish in public and private waters undoubtedly encourages tourism, which in turn stimulates the economies of the rural communities adjacent to these waters.

Response: In 2006, with producer support, the Western Regional Aquaculture Center sponsored a project to assess the economic contribution of the Aquacultural Suppliers of Recreational Fish (ASRF). The objectives of the report were to develop a sampling frame for the industry, its direct customers, and anglers, to document the economic contribution of that industry, and develop a set of outreach materials to educate the public about this topic.

Results: Throughout 2008-2009, surveys were distributed to all ASRF producers, 686 of their direct customers and 1841 recreational anglers in the Western United States. Using IMPLAN input-output models, the economic contribution of the ASRF industry, while accounting for both forward and backward linkages, is estimated to be $1.91 billion dollars and is estimated to support 26,229 jobs annually in the Western United States. Every dollar of ASRF sales results in a multiplier effect of $35.92 dollars generated in the region, and every million dollars of ASRF sales results in 492 full-time jobs.

Impact: This information will ultimately benefit ASRF producers by acting as an educational tool for the general public and for regulatory agencies. As a result, policy decisions may be impartial and thus potentially more favorable than past legislation which was made without the aforementioned information at hand.

Collaborators: Faculty at Colorado State University, University of Arizona, University of California, Davis, University of Idaho, and New Mexico State University, along with Cline Trout Farms, Liley Fisheries and E & J Fish Farms.

Contact: Dr. Craig A. Bond Department of Agricultural and Resource Economics Colorado State University Fort Collins, CO 80523-1172, Craig.Bond@Colostate.edu, (970) 491-6951.

PUBLICATIONS, MANUSCRIPTS AND PAPERS PRESENTED:
Please see list in part 1: Summary. This list includes 10 published articles, 4 working manuscripts, 10 presentations and 3 websites. One student will acknowledge USDA-WRAC funding as he completes his PhD thesis.

SUBMITTED BY: _____ **9-13-10**
Work Group Chair or PI Date

APPROVED: _____ **9-13-10**
Technical Advisor Date