## APPENDIX A:

## REGIONAL ECONOMIC MODELING APPLICATIONS IN HYDROPOWER RELICENSING

Environmental impact statements (EISs) such as those developed by FERC require consideration of regional economic impacts of dam licensing alternatives. The regional economic analyses generally arrive at estimates of how economic output, employment, and taxes would change in response to changes in dam operation. Typically addressed in the "Socioeconomics" section of the EIS, regional economic impacts that FERC characterizes may include the following:

- Loss of local property tax revenue when land values decrease as a result of relicensing conditions. For example, the licensing alternative may include setting aside land in conservation; the limitations in the use of this land may reduce its assessed value and thereby reduce property tax revenues to the local community.[1]

- Jobs and income created directly as a result of construction activity at the project, and the larger regional economic impact in terms of purchases of goods and services from local businesses (see discussion of "multiplier effects" below).[2]

- The regional loss of jobs and economic output that would result when businesses dependent upon power from the dam are threatened by dam removal or other alternatives that would increase the cost of power. FERC will often consider both direct losses at the manufacturing plant as well as multiplier effects.[3]

- The economic impact of recreational expenditures experienced in the baseline project conditions, e.g., expenditures by anglers fishing on reservoirs or rafting activity that relies on current intermittent flow releases.[4]

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[1] See, for example, FERC, *Final Environmental Impact Statement, Deerfield River Projects*, FEIS-0105, August 1996, p. 4-51

[2] See, for example, FERC, *Final Environmental Impact Statement, Kennebec River Basin*, FEIS-0097, July 1997, p. 4-189.

[3] See, for example, FERC, *Final Environmental Impact Statement, Ripogenus and Penobscot Mills*, FEIS-0075, September 1996, p. 5-14.

[4] See, for example, FERC, FEIS-0105, August 1996, op cit., p. 4-51.

## APPENDIX B: ACRONYMS

| | |
|---|---|
| **APEA** | Applicant prepared environmental assessment |
| **BTU** | British thermal unit |
| **cfs** | Cubic foot per second |
| **CV** | Contingent valuation |
| **DEIS** | Draft environmental impact statement |
| **DOI** | Department of the Interior |
| **EA** | Environmental assessment |
| **ECPA** | Electric Consumers Protection Act |
| **EIS** | Environmental impact statement |
| **FERC** | Federal Energy Regulatory Commission |
| **FPA** | Federal Power Act |
| **FWS** | Fish and Wildlife Service |
| **GWh** | Gigawatt hour |
| **kWh** | Kilowatt hour |
| **NEPA** | National Environmental Policy Act |
| **O&M** | Operation and maintenance |
| **OHL** | Office of Hydropower Licensing |
| **OMB** | Office of Management and Budget |
| **WACC** | Weighted average cost of capital |
| **WTP** | Willingness to pay |

FERC does not appear to have systematic rules regarding when certain regional economic analyses are performed. Often analyses are performed in response to concerns of key stakeholders such as the licensee, local landowners, and others who comment on the draft EIS.

The alternative economic methodology recommended in this report focuses on benefits and costs realized in a welfare economic framework, i.e., net changes in overall social welfare that occur under various dam licensing alternatives. By taking this perspective, we ensure that river resources are managed in the larger public interest as opposed to the more specialized economic interests of a single company or local community. The changes in output, employment, and tax revenue therefore have no direct relevance in an analysis of overall social welfare. Nonetheless, parties involved in relicensing may be interested in local economic effects, making it important for FWS and other intervenors to understand the fundamental elements of such analyses.

The purpose of this appendix is to explain the type of modeling that analysts use in estimating the regional economic impacts of a measure such as a change in dam licensing. We then examine additional regional economic impact modeling that could be pursued to provide a more balanced picture of the effect of environmental enhancements that may be considered during relicensing.

## REGIONAL ECONOMIC MODELING[5]

Businesses both purchase output from and supply input to other businesses in a geographic region. As a result, when consumers purchase goods from a particular business, industries that supply goods or services to that business are also affected. For example, consider what happens when visitors to a reservoir recreational area purchase food and drink at dining establishments. A portion of the revenues from these purchases flows to food and beverage distributors, which in turn generates revenues to suppliers of raw materials (e.g., local farms or fishermen). An increase in food and drink sales induces increases in the output and employment of these secondary industries. Conversely, a decrease in food and drink sales results in a decline in regional output and employment greater than the direct losses within the food service sector. The goal of input/output modeling is to capture and quantify these interdependencies within the local economy.

Characterizing the complex linkages and interdependencies of a regional economy requires large amounts of data, carefully sorted and organized by industry. To simplify the analysis, industries that affect the economy in a similar manner are grouped into sectors. Sectors are then assembled in an *input/output matrix*, which enables tracking of flows of goods

[5] Material in this section is drawn from Unsworth, Robert E., Robert W. Patterson, and Douglas A. Rae, *An Economic Analysis of Piping Plover Recovery Activities on the Atlantic Coast*, prepared for U.S. Fish and Wildlife Service, prepared by Industrial Economics, Incorporated, May 1998.

and services. The matrix demonstrates how each sector's input needs are met by the outputs of all other sectors within a specified geographic area.

Manipulation of the input/output matrix generates a set of values known as *multipliers*, which further characterize the regional economy. Multipliers quantify the relationship between the demand for a given sector's output and the corresponding output required of the regional economy. As discussed previously, consumer expenditures have a proportionally larger stimulative effect on the local economy. Increased demand and spending in a given sector ripples through all other industries linked to that sector. Similarly, some of the additional income generated is spent on locally produced goods and services. These expenditures lead to further expenditures, and so on. This cycle does not, however, continue indefinitely. Some of the revenues may be saved, or otherwise expended outside of the local economy. Savings, taxes and expenditures outside of the local economy constitute "leakages", the culmination of which is a reduction of these expenditure cycles to zero.

The multiplier value captures the effects of changes in demand/expenditure in a given sector on the local economy. For example, an output multiplier of 1.7 associated with the food service sector implies that spending $1 for food and drink generates $1.70 in total output by the regional economy (i.e., the equipment manufacturers, raw materials suppliers and all other regional industries). As this example suggests, the regional economic effects of a given industry are proportional to the size of that industry's multiplier.

An important aspect of regional economic modeling is the definition of the study area. Ideally, the area corresponds to the geographic extent of economic relationships through which proposed changes will travel. Such an area includes the actual site of the impact, the location of secondary industries, the residential location of the labor force and the appropriate pathways through which the goods and services flow. Economic data of this nature, however, are rarely available. In most analysis, therefore, county or state data are relied upon to approximate local economic areas.

## POTENTIAL APPLICATIONS OF REGIONAL ECONOMIC MODELING IN RELICENSING

As noted, to the extent that regional economic modeling appears in FERC EISs, it is generally used to characterize the effect of power generation and other advantages of existing project resources. For example, regional economic modeling may be used to examine how regional output and employment would suffer if an industrial power user is forced to shut down or to estimate the effect of proposed construction activities at the project.

The objective of the discussion below is to attune FWS staff to regional economic modeling applications that demonstrate the positive economic implications of license conditions that enhance natural resources. Two areas are likely to be most important from the perspective of FWS: (1) the impact of recreational expenditures; and (2) the impact of commercial fishing.

A number of regional economic modeling systems exist. Below, we review how recreational expenditures and commercial fishing activity could be analyzed using one of these models, MicroIMPLAN (IMpact Analysis for PLANning).[6] Originally developed by the U.S. Forest Service, IMPLAN is used by many state and federal planning agencies to evaluate the economic impact of policy choices. The IMPLAN input/output matrix incorporates data from a number of federal and state entities, including the Bureau of Economic Analysis and the Bureau of Labor Statistics. It is important to note that while IMPLAN may differ from another input/output model in terms of the mechanics of usage, the concepts and objectives we discuss below are not dependent upon the specific model used in the analysis.

## Impact of Recreational Expenditures

As we have noted, many dam relicensing alternatives have the potential to enhance recreational use of river resources. Depending upon the magnitude of the potential effects, FWS or other intervenors may wish to examine regional economic impacts of expected increases in recreational activity. Specifically, expenditures by anglers and rafters may be beneficial to the regional economy in much the same way as power-related economic activity.

### Recreational Fishing

When analyzed in a regional economic framework, the effects of increased recreational fishing can be significant. First, anglers may purchase recreation-related goods and services such as bait, lodging, food, and gasoline. The IMPLAN model allows the user to examine how expenditures from an increase (or decrease) in recreational fishing would ripple through the regional economy. That is, the model estimates the total change in key economic factors -- e.g., output and employment -- for a change in the level of recreational fishing activity.

The key set of information needed to develop such an analysis is a breakdown of expenditures per unit (e.g., day or trip) of recreational fishing. An example of an expenditure profile is provided in Exhibit A-1. These expenditures can by multiplied by the change in the number of fishing days to estimate the change in total direct expenditures. One good source for expenditure information is the Fish and Wildlife Service's *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, which provides average expenditure information for each state.[7] State fish and game departments also frequently develop similar studies of recreational expenditures.

**Exhibit A-1**

[6] Another commonly used model is the Regional Input/Output Modeling System (RIMS).

[7] U.S. Fish and Wildlife Service, *1991 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, 1993.

**AVERAGE EXPENDITURES BY OREGON RECREATIONAL ANGLERS**

| Category | Expenditures per Fishing Day |
|---|---|
| Transportation including gas | $10.54 |
| Lodging | $3.30 |
| Food/drink at stores | $10.04 |
| Food/drink at restaurants | $4.02 |
| Guide and charter fees | $2.55 |
| Boat gas | $2.59 |
| Equipment rental | $1.35 |
| Supplies and misc. | $5.46 |
| Other expenses | $2.30 |
| TOTAL | $42.15 |

Source: Oregon Department of Fish and Wildlife, *Oregon Angler Survey and Economic Study*, June, 1991.

The IMPLAN model accepts information on the change in recreational days and the expenditures associated with this activity. By examining how expenditures in the different sectors (e.g., lodging, grocery stores and restaurants, transportation) ripple through the regional economy, IMPLAN provides an estimate of the total economic activity associated with the change in fishing levels. Specifically, the model estimates the change in output, employment, income, and other indicators.

To illustrate, consider a hypothetical situation where relicensing conditions for a dam in Oregon are expected to create 1,000 new days of recreational fishing. Using IMPLAN and the expenditure profile data from Exhibit A-1, the regional economic benefits could be characterized as shown in Exhibit A-2. The additional fishing activity would create about $42,000 in direct expenditures. The multiplier effect results in a change in output from all sectors of the economy totaling about $97,000. This implies an output multiplier of 2.3 (i.e., the total impact on output is 2.3 times the direct increase in expenditures). The output increase would produce roughly two new jobs statewide.

**Exhibit A-2**

**SUMMARY OF STATEWIDE ECONOMIC IMPACT OF INCREASED RECREATIONAL ANGLING IN OREGON**

| Increase in Fishing Days | Direct Expenditures | Impact on Total Output | Employment Effects (Jobs) |
|---|---|---|---|
| 1,000 | $42,150 | $96,945 | 1.97 |

Source: IEc analysis using IMPLAN. Adapted from U.S. Environmental Protection Agency, *Costs and Benefits of Water Quality Improvements in Oregon's Willamette Valley*, prepared by Industrial Economics, Incorporated, December 1997.

**Recreational Rafting**

Changes in recreational rafting opportunities can be assessed in much the same way as recreational fishing; i.e., expenditures per day or trip are multiplied by the change in activity and the overall impact on the regional economy estimated. Expenditure profiles are somewhat more difficult to obtain for rafting than for fishing. The best option is to seek out previous recreational rafting studies for the river or geographic region in question.

Past studies have used IMPLAN to estimate the economic impact of rafting around dams. For example, Douglas and Harpman used IMPLAN to estimate the employment effects of expenditures on recreational trips to the Colorado River near Glen Canyon Dam.[8] The study first assembled participation data on day-use rafters, private whitewater rafters, commercial whitewater rafters, and anglers using the Lee's Ferry site on the Colorado. Using the IMPLAN model, the authors combined these data with expenditure profiles for each activity and estimated the impact on the larger regional economy. The study found that 586 local jobs are created as a result of recreational expenditures. The authors use the results to demonstrate that: (1) by stabilizing flow, the Glen Canyon Dam enables recreation that is important to the regional economy; and (2) recreational activity is relatively labor intensive and can therefore be important to regional employment levels.

**Commercial Fishing**

Regional economic models such as IMPLAN can also be used to evaluate how changes in the output of key commercial industries affect the regional economy. As noted, in the context of relicensing, FERC has presented regional economic impact results in characterizing the importance of industries (e.g., paper plants) dependent upon the hydropower project in question.

[8] Douglas, Aaron J., and David A. Harpman, "Estimating Recreation Employment Effects with IMPLAN for the Glen Canyon Dam Region," *Journal of Environmental Management*, Vol. 44, 1995, pp. 233-247.

Parties examining licensing alternatives may also wish to use such modeling to characterize the effect of alternatives that enhance natural resources important to commercial industries.

Most notably, effects on commercial fishing may be important if the affected fishery supports anadromous fish or other commercial species. Because commercial fishing supports an extensive market of processors, wholesalers, and retailers, the magnitude of the effect on regional economies (i.e., the multiplier) can be significant.

The most challenging aspect of assessing the regional economic impact of changes in commercial fishing is estimation of how commercial catch will change as a result of the improvement in the fishery. Analyses produced for the EIS frequently estimate total changes in fish stocks for a given licensing alternative. These changes must be combined with information on catch ratios (i.e., the portion of added fish that are caught) as well as data on average fish size to estimate the change in total pounds landed.[9]

Once the analyst estimates the change in fish landings, per-pound ex-vessel price data (available from NMFS) can be used to estimate the value of the catch change. IMPLAN uses this estimate of the increase in output in commercial fishing as the basis for estimating the total regional economic impact of this output change. The change in output in this one sector influences output in a variety of other sectors such as ice manufacturing, fish processing, and boat repair. The final IMPLAN results show how the change in commercial fishing output changes the total output, employment, income, and other economic factors in the region. Such information may be useful in characterizing the practical benefits of licensing alternatives that enhance commercial fisheries.

[9] See Meyer Resources, *An Analysis of FERC/DEIS-0103 - Condit Hydroelectric Project - FERC 2342-005 Washington*, developed for American Rivers and the Yakima Indian Nation, February 1996.

## APPENDIX C: GLOSSARY

**Baseline**

A baseline is a scenario or reference point against which other options or alternatives are compared. FERC has established that the appropriate baseline to use in relicensing proceedings is *the current operation of the project under its existing license and the current waterway environment*. This is referred to as the "no-action" alternative. To evaluate competing uses of a waterway, FERC compares each proposed relicensing alternative with the baseline "no-action" alternative.

**Benefits transfer**

Benefits transfer involves the application of value estimates, functions, data, and/or models from existing studies to estimate benefits associated with the resource under consideration. This approach is considered a "secondary" valuation methodology, since it does not require primary data gathering (e.g., surveys) or other primary economic research.

**Consumer surplus**

The concept of consumer surplus is based on the principle that some consumers benefit at current prices because they are able to purchase goods (or services) at a price that is less than their total willingness to pay for the good. Resource economists generally rely on consumer surplus as a measure of overall changes in economic welfare.

**Contingent valuation**

The contingent valuation method uses survey techniques to directly elicit information on individuals' willingness to pay for goods that are not commonly traded in markets, such as natural resources and the services they provide. Contingent valuation is the predominant type of stated preference technique used to value non-market goods and services.

**Dependable capacity**

Dependable capacity refers to the power a project can reliably be expected to generate during future periods of peak energy demand, such as the afternoon of a hot summer day. For a hydroelectric project, capacity is constrained by the amount of water that can be run through the project to generate power. Through contractual agreements, projects get paid a fixed amount for their dependable capacity (i.e., capacity values do not fluctuate with hour-to-hour changes in supply and demand). In contrast, energy values are variable (i.e., they rise and fall with changes in supply and demand). In FERC's analysis, energy values reflect the average hourly energy value of the project.

| | |
|---|---|
| **Developmental values** | These values are associated with project benefits such as power generation, water supply, flood control, irrigation, and river navigation. |
| **Discount rate** | A discount rate is commonly applied in financial analysis because it provides a means for converting future costs and benefits into present value dollar amounts (i.e., their worth today). The principle behind discounting is the "time value of money" -- i.e., a dollar paid today is worth more than a dollar paid a year into the future because the person holding the dollar can invest it and earn a return. Because the costs and benefits of relicensing alternatives may occur at different times during the 30-year period of analysis, FERC discounts future costs and benefits to their "present value" to make relicensing alternatives comparable. |
| **Environmental measures** | Throughout this report, "environmental measures" refers to actions that would protect, mitigate damages to, and/or enhance the environment. |
| **Externality** | An externality is a side effect borne by parties not directly involved in (i.e., external to) an activity or market exchange. For example, combustion generators may impose air pollution externalities on the surrounding population. |
| **Least cost thermal alternative** | The "most likely thermal alternative" approach is the method most commonly used by FERC to estimate gross power benefits. Under this method, FERC decides which thermal unit (or units) would most likely replace the power currently generated by the applicant's hydropower project. To identify this alternative source, FERC considers the specifics of the hydropower project and circumstances in the regional power market. |
| **Levelizing** | Levelizing is similar to creating an annuity, in that it creates a level stream of equal dollar payments that lasts for a fixed period of time. After discounting, FERC levelizes the present value sums to establish equal net benefit amounts for each year of a relicensing alternative. This allows alternatives to be compared on an annual basis. |

**Marginal benefit/cost**

Marginal benefit refers to the additional benefit from consuming one more unit of a good or service. Similarly, marginal cost refers to the additional cost of producing one more unit of a good or service. Economic theory suggests that a resource is efficiently allocated when the marginal benefit of supplying the good is equal to the marginal cost.

**"No-action" alternative**

FERC has established that the appropriate baseline to use for evaluating relicensing alternatives is *the current operation of the project under its existing license and the current waterway environment*. FERC refers to this baseline as the "no-action" alternative since the alternative requires no changes to current project operations.

**Non-developmental values**

These values are associated with waterway benefits such as fish and wildlife resources, recreational opportunities, and other aspects of environmental quality.

**Non-power values**

These values include services provided by the river, such as fish and wildlife resources, recreational opportunities, and other environmental amenities, as well as services provided by the project, such as water supply, flood control, irrigation, and river navigation.

**Non-use value**

Non-use values are the economic benefits that accrue to those who do not directly use the resource and perhaps never intend to do so. In this report, we use the term "non-use value" to refer to a class of economic benefits that include:

- Existence value, i.e., knowledge of continued existence of the resource;
- Bequest value, i.e., preserving the resource for future generations; and
- Option value, i.e., having the option to use the resource in the future.

**Peaking project**

A peaking hydroelectric project regulates flows to maximize energy values. A peaking project increases flows to generate more electricity during periods of peak demand (when energy prices are high), and reduces flows to store up capacity during periods of low demand (when energy prices are low). Thus, flows through a peaking project may be greater during the day than at night.

| | |
|---|---|
| **Project services** | Beyond power generation, hydroelectric projects may offer services such as flood control, water supply, irrigation, and river navigability. |
| **Revealed preference** | A range of valuation techniques exist under the general category of revealed preference. Revealed preference techniques examine individuals' behavior in markets in response to changes in environmental or other amenities, i.e., people "reveal" their value by their behavior. For example, people may exhibit their value for environmental quality through purchases in the housing market, paying more for homes near clean water, conservation land, or other environmental amenities. |
| **Run-of-river project** | A run-of-river hydroelectric project allows the river to run through the project; flows are not regulated as they are by a peaking project. |
| **Stated preference** | Stated preference approaches are used to value environmental and other amenities when no market, either direct or indirect, exists for them. At a basic level, stated preference approaches involve asking individuals about the value they place on amenities such as natural resources, i.e., respondents "state" their values. Contingent valuation is the predominant type of stated preference technique used to value non-market goods and services. |
| **Sunk costs** | A sunk cost is a cost that has already occurred and cannot be changed by future decisions. In FERC's analysis, sunk costs are usually included as "net investment costs" -- previous expenditures that have created financial obligations for the future. |
| **Use value** | Use values associated with natural resources include values for goods and services that humans realize through direct or indirect use of the resource; e.g., swimming in a lake, aesthetic enjoyment of a forest. |
| **Willingness to pay** | Economists have refined methods to measure individuals' "willingness to pay" for various amenities, including environmental amenities not typically bought and sold in markets. Willingness to pay represents the amount of money an individual would give up to receive an increase in such an environmental amenity. |

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