PROPOSED HYDROELECTRIC POWER PLANT LOCATIONS: INYO AND MONO COUNTIES

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Introduction

The number of permit applications for small hydroelectric power plant development (less than 25 Mw) in Inyo and Mono counties has increased dramatically since 1980. The availability of undiverted streams with suitable gradients and flow rates, Federal land ownership, and regulatory and economic incentives have resulted in increased numbers of applications to the Federal Energy Regulatory Commission (FERC).

The development of California water resources has consistently been an important field for geographic research and application. The *Central Valley Project Studies*, development of statewide water plans, and publication of the landmark *California Water Atlas* all used geographers.[1] The future of the State Water Project and the management of Owens Valley water resources are two of the more controversial issues recently examined from a geographic perspective.[2]

The State Water Resources Control Board (SWRCB) recently ordered that a "cumulative impact" study of potential regional economic and environmental impacts associated with small-hydro development in Inyo and Mono counties must be completed prior to approval of pending applications.[3] The unique perspective and skills that geographers possess are well suited

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to this type of regional resource analysis.

A significant problem for government agencies charged with evaluating potential impacts is a lack of aggregate locational information on all proposed projects. The precise locations of all proposed small-hydro facilities in Inyo and Mono counties are unavailable in a unified tabular or cartographic form.[4] The design of a map illustrating the location of all proposed projects is essential to the aforementioned regional analysis and is the primary objective of this report.

The main body of the paper includes a discussion of the importance of the research problem in a regional context, an analysis of incentives for small-hydro development in Inyo and Mono counties, an outline of research objectives, a review of the methodology, and a presentation of the project results.

Regional Analysis

Project locations currently can be determined only by reviewing individual FERC application notices, a time-consuming and inefficient process which greatly hinders any effort to visualize the potential impacts of proposed small-hydro development on a regional basis. A regional, dual-county evaluation is necessary to determine the cumulative nature of any environmental, economic, or cultural impacts which may result if aggressive development of the small-hydro resource is pursued.

Theoretically, while individual project impacts might be localized and manageable, the impact of up to several dozen such projects could be detrimental to the region's biological and economic environment. Confirmation of such a hypothesis would be difficult, if not impossible, were a regional approach not used. Rhoads Murphey wrote that, "The regional whole must be understood as the context in which any of its parts are to be examined since all of its parts are interrelated."[5] Numerous inquiries into water and energy issues have successfully employed a regional concept and the December, 1982, SWRCB ruling mandated a regional approach in the small-

hydro study of Mono Basin and the Owens Valley.

Regulatory and Economic Incentives

Proposed hydroelectric projects in the Inyo-Mono region are targeted for relatively small streams, most with an average annual stream flow of less than 35 cubic feet per second.[6] Flow rates for six Inyo-Mono streams and three larger rivers in California are listed in Table 1.

Steep stream gradients compensate for low flow rates to provide potential generating capacity. Previously, these conditions would not have justified development of the resource. However, recent changes in energy regulatory and tax credit policies at both the Federal and State level have provided more than adequate incentive to a host of public- and private-sector project sponsors to pursue small-hydro development.

Table 1
Stream Flow Rates

Stream	Mean Annual Flow (cubic feet per second)
Tinemaha	7
Independence	12
Cottonwood	22
Rock	26
Lee Vining	68
West Walker	205
Kern	598
Tuolumne	1162
Feather	7040

Sources: Michael Donley, Stuart Allan, Patricia Caro, and Clyde Patton, *Atlas of California* (Culver City: Pacific Book Center, 1979), p. 143; California Department of Fish and Game, Bishop Office, small-hydroelectric power project files.

The Federal Public Utility Regulatory and Policy Act of 1978 (PURPA) requires FERC to establish rules encouraging small power production, requires investor-owned utilities to purchase such power, and authorizes certain exemptions from Federal and State permit processes. New Federal and State tax laws also provide numerous energy tax credits, loan guarantees, and bond programs for small power producers. Pending in the California legislature are bills requiring investor-owned utilities to pay small power producers avoided-cost rates for energy and to provide those producers interconnection with existing utility distribution grids.[7]

The result has been a flood of applications to FERC for permits to develop small-hydro projects in California. The California Department of Water Resources (DWR) reports more than forty projects in the Inyo-Mono region alone.[8]

Objectives

Development of the small-hydro resource is partly contingent upon satisfactory sponsor compliance with Federal and State statutes designed to protect physical, biological, and cultural resources from any adverse environmental impact. Inyo National Forest and California Department of Fish and Game (DFG) are the lead agencies in assessing potential environmental impacts of each project. The potential for individual and cumulative adverse impacts is well documented.[9] Inyo National Forest and DFG are simultaneously evaluating proposals on a site-by-site basis and attempting to assess the cumulative impact that widespread small-hydro development would have on the Inyo-Mono region.

In an effort to alleviate a critical deficiency in project location data essential to a cumulative regional hydropower analysis, three primary research objectives were designed: development of a master list of small-hydro projects proposed for Inyo and Mono counties, to include FERC number, stream, and installed capacity; location of each proposal on U.S. Geological Survey (USGS) fifteen-minute topographical

quadrangles; and drafting a map of project locations at a scale of 1:250,000.

Methodology

Information necessary to compile a project list and draft a project map was located through a lengthy and detailed document search and review. California DWR publications on existing and proposed small-hydro resources provided the initial data on a majority of Inyo-Mono projects, including targeted streams, FERC numbers, installed capacity, and project sponsor. Subsequent examination of FERC application notice summaries in the *Federal Register* gave further project specifications but no accurate locational data.[10] The *Inyo County Small Hydroelectric Workbook* also was lacking in this respect, although additional projects were identified from both the *Workbook* and *Federal Register.*

Copies of FERC application notices for each proposal in the Inyo-Mono region, located at the DFG office in Bishop, proved to be the only useful source of accurate project locations. The FERC notices and accompanying documents (environmental studies, government reports) provided a wide range of both type and quality of locational data. Several notices included detailed topographical maps or township and range location while others provided only small-scale regional maps, stream names only, or verbal descriptions. Additional projects were discovered in the DFG files and added to the list. This data accumulation process emphasized both the difficulty in attempting a regional analysis of cumulative project impacts without necessary data and the immediate need for such summaries of locational information by DFG and Inyo National Forest.

Project specifics pertinent to the research objectives were then tabulated by both FERC number and stream location to permit cross referencing. Projects were located on USGS fifteen-minute topographic maps as accurately as on-file data would allow. A base map (1:250,000) of the Inyo-Mono region with overlays depicting current hydroelectric development and

proposed small-hydro project locations was then drafted.

Results

Research findings are presented in both tabular and cartographic form. Complete listings of proposed small-hydro projects are arranged by FERC number and stream location (Table 2 and Table 3, respectively). Existing hydro-electric development within the region and proposed small-hydro projects are illustrated on separate maps (Figure 1 and Figure 2, respectively). Sixty-two small-hydro projects are listed and of those, forty-eight are accurately located on topographic quadrangles and the regional map produced here (Figure 2). Several of the listed projects consist of more than one powerhouse; this accounts for the more than forty-eight powerhouse symbols in Figure 2. In addition, there are competing FERC applications for development at several sites and these also are noted in Figure 2. Only a general site for each of the remaining fourteen proposals is known because of a lack of precise locational data on individual FERC application notices or accompanying documents.

Table 2
Proposed Hydroelectric Development
Arranged by FERC Number

FERC No.	Stream	Installed Capacity (kW)
3189	Lee Vining (now 3272)	—
3242	Rock	2500
3252	Green	*
3258	Pine	2000
3259	Wilson	1027
3272	Lee Vining	428
3413	Millner	700
3497	Millner	658
3525	Cottonwood, Lone Tree	417
3580	Piute	400

3582	Convict	300
3583	Horton	1400
3695	Pine	4680
3741	McGee	433
3835	Coldwater	350
3884	Morgan	950
4009	Millner	400
4051	Mill	*
4267	Piute	400
4314	Green	700
4669	Bishop	600
4854	Coldwater	100
5004	Bridgeport Dam	*
5115	Morgan	1450
5263	Independence	17,200
5277	Big Pine	8200
5280	Birch, Tinemaha, Goodale	10,050
5310	Cottonwood	4050
5329	Lone Pine	2700
5380	Goodale	2970
5381	Birch, Tinemaha	7180
5382	Little Pine	1700
5383	Lone Pine	1370
5384	Baker	600
5385	Big Pine	1370
5386	Independen	4950
5387	Cottonwood	4050
5425	West Walker	6200
5493	West Walker	22,720
5527	Little Walker	1300
5528	Silver	1700
5529	West Walker	6200
5599	Rock, Falls	30
5621	Rock	4000
5622	Virginia (now 6549)	—
5623	Robinson	*

5632	Marble	250
5852	Oak	100
5910	Baker, Big Pine	1720
5914	Big Pine	500
5933	Wolf	450
5934	Leavitt	450
5943	Cottonwood	8700
6114	Big Pine	5000
6134	West Walker	300
6135	Lost Cannon	*
6148	Tinemaha, Independence, Cottonwood	1500
6156	Pellisier, Middle Canyon, Birch	420
6158	Independence	*
6186	Birch, Tinemaha, Red Mountain	*
6187	Spring Canyon	*
6188	Tinemaha, Red Mountain	*
6549	Virginia	675
(CA.26570)	Warren Fork[a]	*

Note: *data not available.
[a]FERC number not available; SWRCB Water Right Application Number given.

Table 3
Proposed Hydroelectric Development
Arranged by Stream, North to South

Stream	FERC Number
Spring Canyon	6187
Lost Cannon	6135
Mill	4051
Silver	5528
Wolf	5933
Leavitt	5934
West Walker	5425, 5493, 5529, 6134
Little Walker	5527
Bridgeport Dam	5004
Robinson	5623
Green	3252, 4314
Virginia	6549
Wilson	3259
Warren Fork	(CA.26570)
Lee Vining	3272
Convict	3582
McGee	3741
Rock	3242, 5621
Morgan	3884, 5115
Pine	3258, 3695, 3884, 5115
Horton	3583
Bishop	4669
Marble	5632
Rock	5599
Falls	5599
Pellisier	6156
Middle Canyon	6156
Birch	6156
Cottonwood	3525
Lone Tree	3525

Millner	3413, 3497, 4009
Piute	3580, 4267
Coldwater	3835, 4854
Baker	5277, 5384, 5910, 5914, 6114
Big Pine	5277, 5385, 5910, 5914, 6114
Little Pine	5277, 5382, 5914, 6114
Birch	5280, 5381, 6186
Tinemaha	5280, 5381, 6148, 6186, 6188
Red Mountain	6186, 6188
Goodale	5280, 5380
Oak	5852
Independence	5263, 5386, 6148, 6158
Lone Pine	5329, 5383
Cottonwood	5310, 5387, 5943, 6148

The project listings and maps provide conclusive evidence of the intense degree of proposed development of the small-hydro resource in Inyo and Mono counties. Complete development would tap nearly every remaining perennial stream flowing down the east slope of the Sierra Nevada south of Sonora Pass. Together with planned development in the White Mountains northeast of Bishop and existing hydro-electric projects, hydropower generation could become a significant land use throughout the region (Figure 2).

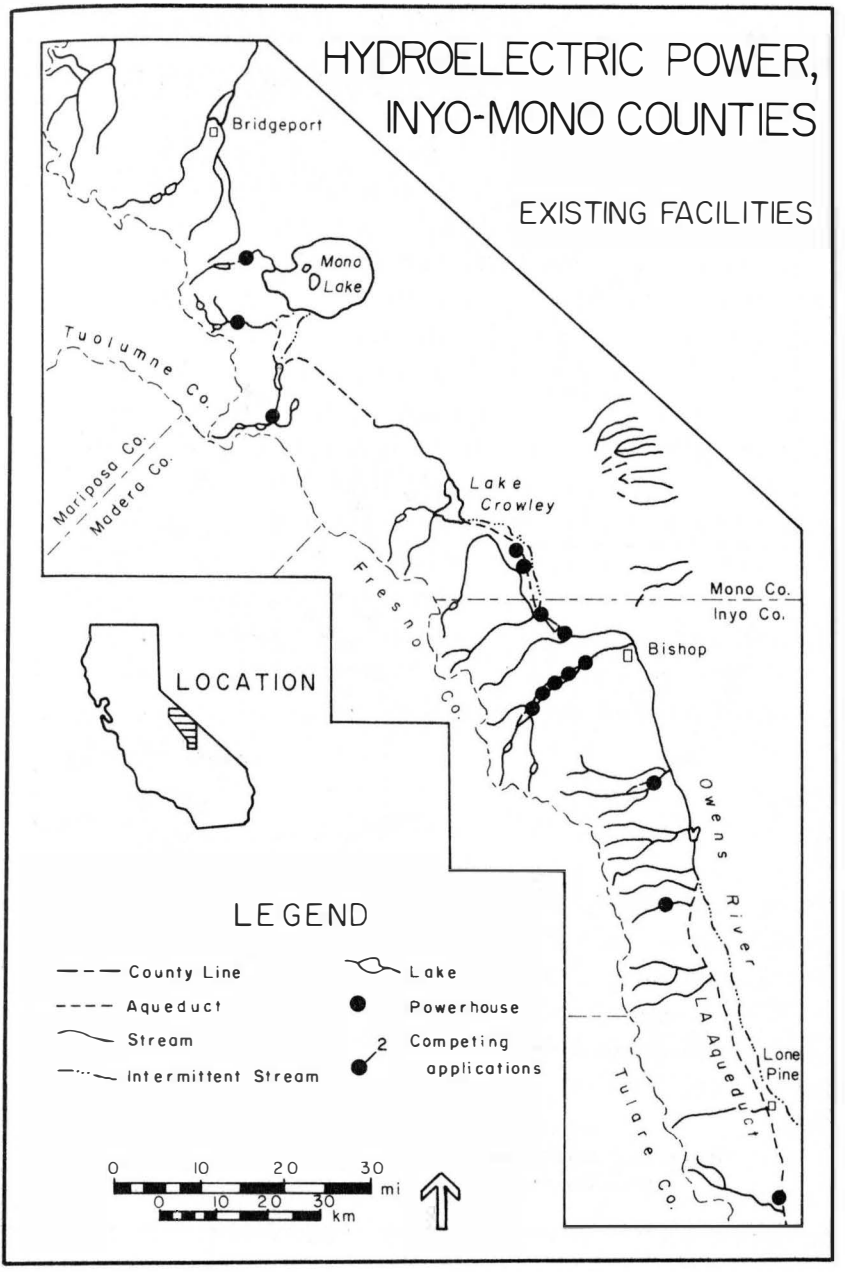
HYDROELECTRIC POWER,
INYO-MONO COUNTIES
EXISTING FACILITIES
Bridgeport
Mono Lake
Tuolumne Co.
Mariposa Co.
Madera Co.
Lake Crowley
Fresno Co.
Mono Co.
Inyo Co.
Bishop
LOCATION
Owens River
LA Aqueduct
Lone Pine
Tulare Co.
LEGEND
County Line
Aqueduct
Stream
Intermittent Stream
Lake
Powerhouse
Competing applications
0 10 20 30 mi
0 10 20 30 km

Figure 1

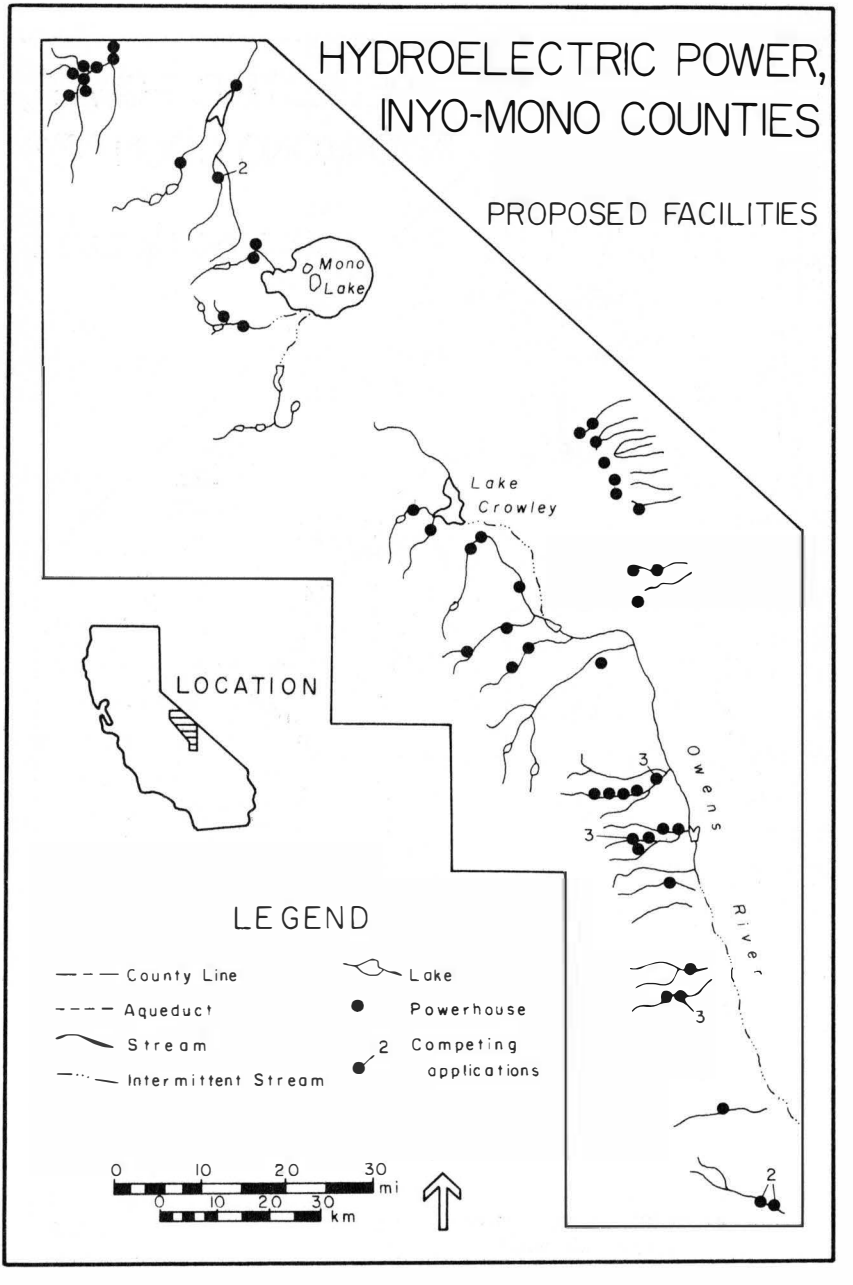
HYDROELECTRIC POWER,
INYO-MONO COUNTIES
PROPOSED FACILITIES
Mono Lake
Lake Crowley
Owens River
LOCATION
LEGEND
County Line
Aqueduct
Stream
Intermittent Stream
Lake
Powerhouse
Competing applications
0 10 20 30 mi
0 10 20 30 km

Figure 2

Summary

Suitable hydrologic conditions in the eastern Sierra Nevada coupled with a favorable regulatory and economic climate toward small power production have resulted in a large number of applications for small-hydro development in Inyo and Mono counties. A regional understanding of the potential cumulative impact on the environment from wide-spread small-hydro development has been hampered by the absence of a complete listing and a regional map of proposals for both counties. A detailed review of all available government documents and project summaries has provided a tabulation of proposed projects and a map accurately locating these projects.

The results of this study indicate the potential areal extent of total development of the small-hydro resource and will assist in efforts to identify potential cumulative impacts on scenic, recreational, and fishery resources. Evaluating small-hydro development decisions in a regional context rather than on an individual site basis appears logical based on the large number of proposals and the potential for near-complete use of all perennial stream flows in both counties for hydroelectric power generation.

NOTES

1. United States Department of Agriculture—Bureau of Agricultural Economics, *The Effect of the Central Valley Project on the Agricultural and Industrial Economy and on the Social Character of California. A Report on Problem 24, Central Valley Project Studies* (Berkeley, 1945), pp. x-xxii, 13-24; H. J. Wood, "Water for the Great Valley of California," *Economic Geography*, 14 (1938), pp. 354-362; E. Eiselen, "The Central Valley Project: 1947," *Economic Geography*, 23 (1947), pp. 22-31; L. M. Cantor, "The California Water Plan," *Journal of Geography*, 68 (1969), pp. 366-371; California Department of Water Resources, *California Water Atlas* (Sacramento, 1979).

2. R. Walker and M. Storper, "The California Water System: Another Round of Expansion?", *Public Affairs Report*, 20 (1979), pp. 1-11; California Department of Water Resources, *Owens Valley Groundwater Investigation, Phase 1, Appendix C* (Sacramento, 1980), pp. 35-65.
3. *Inyo Register* (Bishop, California), 9 December 1982, p. 1.
4. Bill Loudermilk, California Department of Fish and Game (Bishop Office), personal communication, 5 November 1982.
5. R. Murphey, *The Scope of Geography* (Chicago: Rand McNally Publishing Company, 1973), p. 106.
6. D. W. Taylor, *Eastern Sierra Riparian Vegetation: Ecological Effects of Stream Diversions* (Lee Vining, Calif.: Mono Basin Research Group, 1982), p. 19.
7. P. Gipe, "PURPA: A New Law Helps Make Small-Scale Power Production Profitable," *Sierra*, 66 (1981), pp. 52-55; L. Pemberton, "Small Hydro Briefing," in *Inyo County Small Scale Hydroelectric Workbook* (Bishop: Inyo County Water Department, 1982), p. 3; California Department of Water Resources, *Update, Analysis of Recently Proposed Hydropower Projects in California, Including Environmental Impacts* (Sacramento, 1982), pp. 4-12.
8. Ibid., p. 12.
9. Ibid., pp. 14-17; Taylor, op. cit., pp. 7-33.
10. *Federal Register* (Washington, D.C.: U.S. Government Printing Office), Vols. 45-47, 1980-1982.