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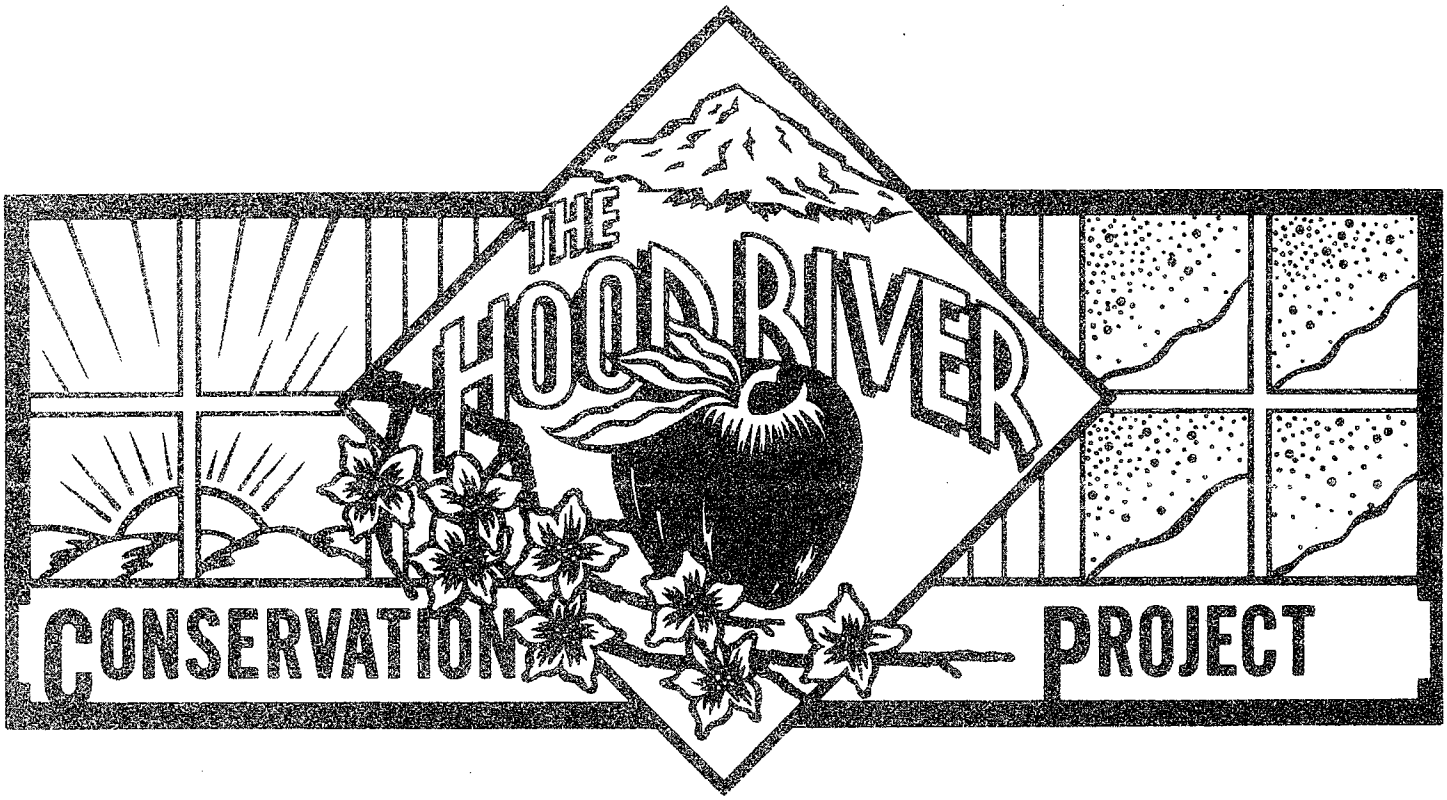
Research Plan:
Hood River Project Evaluation

Final Report



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RESEARCH PLAN: HOOD RIVER PROJECT EVALUATION

Final Report

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Section 1: Objectives -- Questions to be Answered in the Hood River Conservation Project Evaluation

Evaluation objectives are listed in this overview, and detailed in the appropriate section of the evaluation plan. Evaluation tasks are classed under three major objectives: Energy Savings, Capacity/Diversity Effects, and Process Evaluation (which includes assessment of program implementation and communication techniques). Other evaluation objectives, such as analysis of penetrations and physical/behavioral barriers to implementation of measures, are considered as aspects of the major objectives.

The Energy Savings Impact

One of the major objectives of the evaluation plan is to permit accurate assessment of the energy (kWh) savings impact of the conservation program. This objective includes consideration of overall impact and impact of measures, and to the extent possible, levels of measures. In addition, physical barriers will be assessed. Evaluation questions under this objective are as follows:

1. What overall energy (kWh) savings can be achieved by implementing a reasonably high standard of conservation measures in a community program in which ability to pay is not a barrier to acceptance of weatherization, along with an intensive community campaign?

2. What penetration can be achieved by the program?

3. What penetration can be achieved for specific measures?

4. What savings can be estimated for specific measures? How do estimated (audit) savings and actual savings compare? What are the quantitative and qualitative effects of these comparisons in relation to the question of comparison of current heat loss methodologies?

5. What levels of measures are actually attainable? What tentative estimates can be developed regarding energy savings due to levels of measures?

6. What are the physical barriers to implementation of a reasonably high standard of conservation measures? What is the relative

frequency of specific physical barriers to specific measures? Are there dwelling characteristics that correlate highly with these barriers, which might serve as readily available indicators for use in planning?

Feeder Study: Capacity and Diversity Effects

A second major objective of the evaluation is to assess the capacity (kW) effects of the program. The primary vehicle for this assessment will be a feeder study, although plans also call for feeder-level monitoring of all community feeders. There are two principal evaluation questions under this objective:

1. What are the capacity (kW) effects obtained from implementation of a reasonably high standard of conservation measures in a community program in which ability to pay is not a barrier, along with an intensive community campaign?

2. What are the capacity (kW) and diversity effects on a primarily residential feeder obtained by implementing a reasonably high standard of conservation measures with high residential penetration?

Evaluation of Program Implementation and Process

The third major objective is focused on the program as a process. Evaluation questions in this area concern program implementation and evaluation of communications media and techniques:

1. What can be learned about the process of program implementation and potential constraints induced by the magnitude of an intensive conservation campaign?

    a. What are the program goals of the Hood River Conservation Project, as planned and defined? In which respects did program implementation support planned goals? In which respects did the actual delivery of program services differ from delivery as planned? What events or factors emerged in the course of the project which introduced changes in the ways the program was implemented and perceived? Did the project generate

any unanticipated consequences? What aspects of the project were responsible for unanticipated developments? Which aspects of the project were essential (and which probably irrelevant) in attaining the achieved degree of success in accomplishing program goals? What can be learned about how similar programs might be implemented in the future?

b. Did the size and intensity of the project generate any institutional constraints? Was supply of required material bottlenecked due to the size or timing of demand? Was project timing and generation of expectations keyed to the ability to deliver services? If not, what were the consequences? Was quality of construction affected by the number of homes being weatherized during a given period of time? Was quality control of inspection efforts affected by the size of the workload?

2. Which communication media, techniques, and sequencing appear to be most effective in promoting participation in audits and then in promoting the decision to weatherize? What are the factors influencing participation and non-participation?

   a. How do program characteristics (such as eligibility requirements, specific measures and levels offered, flexibility in meeting customer preferences, the interaction style of program service deliverers, program image, etc.) affect participation in audits and the decision to weatherize? What influence do these program dimensions have on the effectiveness of communication media and techniques, and how do both sets of factors interact in promoting acceptance of the audit and subsequently the acceptance of weatherization?

   b. Similarly, how do customer characteristics (such as demographics, attitudes toward conservation, previous experiences, etc.) influence acceptance of the audit and the subsequent decision to weatherize? How do these customer dimensions interact with communication to promote program goals?

   c. How do the community dimensions of the program (such as bandwagon effect, influence of community leaders, image of the program in the community, etc.) influence acceptance of the audit and the subsequent decision to weatherize? How do these

community dimensions interact with communication to promote program goals?

d. Why do people accept (refuse) audits in a community based conservation program? Why do people weatherize in the context of a community based conservation program with an intensive community campaign? Why do people who accept audits sometimes decide not to weatherize, even when the barrier of ability to pay is removed? What are the remote and proximate aspects of the decision to weatherize (not weatherize)? What elements constrain a decision? What elements may "trigger" a decision? What are people's expectations as to the outcomes of their decision to weatherize? What role does the perception of "an experiment" play in the process of decision? What patterns emerge in a joint analysis of communication, program, customer, and community dimensions that will be useful in interpreting the Hood River Conservation Project experience and in implementing future conservation programs?

Section 2: Energy Savings Impact of the Hood River Conservation Project

Accurate assessment of the overall energy savings (kWh) impact of the Hood River Conservation Program is a major evaluation objective. In addition, questions of program penetration, penetration of measures (and physical barriers to implementation), and comparison of heat loss methodologies will be outlined in this section of the evaluation plan.

Overall Energy Savings Due to Program

The key question is: "What overall energy (kWh) savings can be achieved by implementing a reasonably high standard of conservation measures in a community program in which ability to pay is not a barrier to acceptance of weatherization, along with an intensive community campaign?" The evaluation design, analytic approach, and sample design proposed for reaching an answer to this question are detailed below, along with a listing of principal variables to be used in the analysis and a specification of research products.

Evaluation design

The assessment of overall savings will be carried out using a modified multiple time-series research design (Campbell & Stanley, pp. 55-57). The analysis groups specified in the design (see Table 1) include two Hood River groups[1] (those weatherized in 1982 and those weatherized in 1983), two comparison communities,[2] and a random sample of residential customers in the Pacific Northwest (PNW).

Use of comparison groups will provide protection against unusual events which might distort estimation of savings due to the Hood River Conservation Program. For example, an oil embargo, an energy shortage, or an increase in international tensions leading to some sort of federally stimulated mobilization or energy conservation campaign would affect analysis groups more-or-less equally. Additional effects of the Hood River Conservation Program could be separated from those due to the emergence of such national or regional events. Also, the use of time-series measurement (use of kWh data from each of several years) permits control for any gradual cumulative chan-

[1]These groups were later combined into one group, those weatherized by the Project.

[2]The Oregon communities chosen were Pendleton and Grants Pass.

ges across the analysis groups. Loss of observations (for example, by deaths and moves out of the community) may be expected to be about the same across groups.

Table 1. Energy savings multiple time-series design

Analysis Group	1977	1978	1979	1980	1981	1982	1983	1984
Hood River Community #1	0	0	0	0	0	X	0	0
Hood River Community #2	0	0	0	0	0	0	X	0
Comparison Community #1	0	0	0	0	0	0	0	0
Comparison Community #2	0	0	0	0	0	0	0	0
PNW/Pacific Random Sample	0	0	0	0	0	0	0	0

O = Observations
X = Hood River Conservation Program weatherization

The possibility that savings estimates might be biased by some unknown difference between people in Hood River and other places is made unlikely by using three comparison groups: two communities judgmentally selected to be "like" Hood River (both preferably in Oregon to keep rate experience equal), and a random sample of Pacific Power & Light's (Pacific) customers in the Bonneville Power Administration (Bonneville) region. The use of a second comparison community is designed to provide some insurance against the possibility that comparison with a single community might fail if some singular event occurred within the single comparison community during the course of the project (a local conservation mobilization, some unexpected political development, etc.). Similarly, the random sample of Pacific's customers in the Bonneville region will permit comparisons to reveal the generalizability of results.

Measurement processes are not likely to influence results in a biased fashion since the basic measurement of energy (kWh) is routine and generally unnoticed, and the relevant surveys ("pretest" and "posttest" -- see Section 7) will be applied equally in Hood River and the comparison groups. The Hood

River community will, in addition, receive other surveys ("audits" and "market" -- see Section 7), but these can be considered indistinguishable from the community campaign in customer perception. The possibility of statistical regression bias between Hood River and comparison groups is virtually ruled out by the use of three comparison groups with no weatherization-related selection criteria. The time-series design will permit investigation of regression bias as a precaution against misinterpretation.

The possible interaction of "testing bias" with weatherization and the possible interaction of "selection" with weatherization need not present a threat to interpretation of results because these interactions can be considered logical extensions of the community dimension of the program. The possibility of special behavior due to knowledge of the experimental nature of the project remains an open question. However, it can be argued that pursuit of a reasonably high standard of conservation measures in a community by means of mobilization through a community campaign encompasses deliberate "reactive arrangements," and equivalent implementations would be employed in other community mobilizations. Savings data derived from the Hood River Conservation Program should represent both a "high water mark" of reasonably attainable conservation and results generalizable to other community campaigns with similar features.

An additional virtue of the multiple time-series design is that it provides sufficient blocking of rate induced conservation effects. First, an Oregon comparison group (Comparison Community #1) will undergo identical rates and rate changes as Hood River. The comparison of Hood River groups (Hood River Community #1 and #2) with Comparison Community #1 will "net out" rate induced conservation. Second, applicable rate and rate change data collected for Hood River Electric Cooperative (HREC), Pacific's Oregon communities, Comparison Community #2, and residences within the PNW/Pacific random sample will permit supplementary analysis and statistical control of rate effects, if necessary.

Approach to analysis of overall energy savings

Fundamentally, the problem is to address differences in mean consumption (kWh) per dwelling unit in two sorts of comparison: "after" vs. "before" weatherization within the Hood River community and "treatment group" (Hood River) vs. "comparison group" (Comparison Community #1, Comparison Community #2, PNW/Pacific Random Sample). Within this basic approach, several types of comparisons are required to show the degree of similarity across analysis

groups and to derive an indication of the trend over time within each analysis group. As a practical matter, however, total annual residential consumption is affected by weather during the winter heating season, so energy consumption (kWh) will be weather-adjusted at the dwelling unit level using a billing cycle degree day approach or other suitable technique.[3]

The analytic technique to be employed is a generalized multiple regression/correlation approach with a hierarchical model for unique partitioning of variance. Within this approach, both analysis group and weatherization will be introduced as nominally scaled research factors and group means will be compared in an analysis of variance sense with a protected t-test (Cohen & Cohen, pp. 171-211).

Sample design

The sample design for analysis of overall energy savings will provide a basis for two levels of detail in the comparisons described above. At the most basic level, the sample for these comparisons will include all members of the analysis groups (all households in Hood River Community #1, all households in Comparison Community #1, every dwelling unit in the PNW/Pacific Random Sample, etc.). For more detailed comparisons, in which more variables are taken into account, the sample will be limited to those households included in the "pretest" or "posttest" surveys (see Section 7). It is expected that differences between Hood River and other analysis groups (effect sizes) will be larger for energy measures (kWh) than is usually the case due to the high standard of measures and community comparison.

Variables employed and data sources

Energy consumption (kWh), the key variable in the analysis, will be obtained from accounting records of the two utilities serving Hood River. At least five years of such billing record data is currently available from billing records for Pacific customers in Hood River, Comparison Community #1, Comparison Community #2, and the PNW/Pacific Random Sample. Additional years of energy data will be collected from billing records during the course of

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[3]The approach chosen was the Princeton Scorekeeping Method (PRISM), a regression model based upon average daily temperatures. See Fels (1986) for further methodological detail.

the project and project evaluation. Other variables to be included in the analysis will be collected from surveys (see Section 7).

Research products

Several comparisons will be performed in addition to the main comparison of Hood River with the other analysis groups.

1. Energy savings: Hood River vs. other groups.[4]
   a. Hood River vs. Comparison Community #1.
   b. Hood River vs. Comparison Community #2.
   c. Hood River vs. PNW/Pacific Random Sample.

2. Energy savings: Stability of comparison groups.[5]
   a. Comparison Community #1 vs #2.
   b. Comparison Community #1 vs. PNW/Pacific Random Sample.
   c. Comparison Community #2 vs. PNW/Pacific Random Sample.

3. Survey comparisons: Attitudes and characteristics.[6]
   a. Hood River vs. Comparison Community #1.
   b. Hood River vs. Comparison Community #2.
   c. Hood River vs. PNW/Pacific Random Sample.
   d. Comparison Community #1 vs. #2.
   e. Comparison Community #1 vs. PNW/Pacific Random Sample.
   f. Comparison Community #2 vs. PNW/Pacific Random Sample.

Penetration of Program

Evaluation design

An important component of the Hood River Project lies in assessing the degree to which an aggressive residential conservation program will be accepted by members of a community when ability to pay is removed as a barrier

[4]Results published by Hirst et al. (1987). Electricity Use and Savings in the Hood River Conservation Project.

[5]Ibid.

[6]Results published by Kaplon et al. (1987). Final Report on Baseline and Follow-After Surveys.

to program participation and when the program is complemented by an active marketing and communication campaign. This phase of the project separates this study from other work in the field by complementing usual savings/household findings with others relating to the proportion of the housing stock which can reasonably be treated.

This phase of the project will employ a form of the non-equivalent control group design (Campbell and Stanley, pp. 47-50), which permits comparison of experience in the experimental group with those of other groups not exposed to treatment. As shown in Table 2, this design parallels those of other phases of the project evaluation in that events in Hood River are compared to events in two comparison communities and to a random sample of Pacific customers from throughout the company's service area. With influences arising out of other sources statistically controlled, this design permits the estimation of effects associated with the differences between the Hood River program and those available to the comparison groups.

Table 2. Program penetration non-equivalent control group design

Analysis Group	1982/83		1983/84
Hood River	0	X	0
Comparison Community #1	0		0
Comparison Community #2	0		0
PNW/Pacific Random Sample	0		0

O = Observation
X = Treatment

This particular application of the non-equivalent control group design differs from most others, including those described elsewhere for other evaluation components of this project. The difference centers on the use of the initial observation in Hood River. Since the experimental treatment -- the Hood River Conservation Project -- is substantially different from other conservation programs availed to these households in the past, the evaluation of this program's penetration is most accurately envisioned as involving only

the treatment and posttreatment observation to take place in that locale. This part of the evaluation comprises the (X . . .O) component of the table above: it is not pertinent for this particular purpose to conduct a pretreatment observation.

It is, however, appropriate to observe the community prior to introduction and implementation of the program in order to assess Hood River's preproject comparability to the three comparison groups. This assessment is important to comparisons based on postproject observations. As a consequence of these factors, the initial Hood River observations primarily serve a cross-sectional role, and only indirectly contribute to longitudinal comparisons. This quality of the design is graphically indicated in the section through the notation (O) for preproject observations in Hood River. Pre- and posttreatement observations among the three comparison groups will permit measurement of the conservation activities which occur among members of those groups.

Approach to analysis of program penetration

The analytical work undertaken in support of this evaluation issue differs from most others in the project in that the program-eligible housing stock in each community constitutes the unit of analysis: in most other evaluation areas, the object of attention is the individual household. The major consequence of this difference -- to be discussed shortly -- lies in the variables to be used.

Analytical techniques, however, can be similar to those employed elsewhere. While conservation treatment constitutes the measure of principal interest, it is reasonable to anticipate that a number of influences other than program availabilities will influence penetration rates. For this reason, analytical techniques based on analysis of covariance are planned. These permit the statistical control of other determinants and so allow the assessment of net program effects on the adoption of conservation measures.

Sample design

Three of the four groups to be analyzed will have been selected through purposive methods. The criteria which led to the selection of Hood River as a test site are specified in the appendix. The selection of the two comparison communities will be similarly based on a number of criteria which address

their comparability with Hood River, including the provision of electrical service by Pacific. Pacific's service is suggested to simplify data collection, since Pacific's consumption records are efficiently maintained and readily available to the project.

It is suggested that members of the PNW/Pacific Random Sample, however, be selected through probability sampling techniques from Pacific's customer accounting records. While the exact size of this sample of customers remains to be determined, it must be of sufficient scale to permit an accurate description of the population it represents in the project: accordingly, it is currently envisioned that this group will number approximately 600.

Variables to be employed and data sources

While most other analytical work undertaken in the project focuses on individual households and so employs variables representing household characteristics, this analytical component will address the community and will employ variables descriptive of the locale. As a result, household characteristics will be described in terms of saturation rates and other summary measures.

Variables to be employed in these analyses will include characteristics of the housing stock (to be obtained from surveys and from energy audits), of occupants (taken from surveys), and of the community as a whole. Among the last group of measures will be such variables as unemployment rates (taken from sources issued by the State of Oregon) and temperature (from NOAA records). The focal variable for this project phase -- conservation status -- will be obtained from one of two sources. In Hood River, eligible households and participants will be identified through project records. Conservation status in the comparison groups will be determined through Pacific's conservation program records and through project surveys.

Research products

This component of the project evaluation will yield the following kinds of information:

1. Measures of Hood River Conservation Project penetration.[7]

[7]Results published by Hirst and Goeltz (1986). Dynamics of Participation

2. Measures of conservation activity among members of the comparison groups.[8]
3. Measures of net differences in conservation activity associated with the Hood River Conservation Project.[9]
4. Measures of the effects of selected community-specific influences on conservation activities of residents.[10]
5. Measures of Project participation changes over time.[11]

Penetration of Measures

Evaluation design

An issue which is parallel to the penetration of the program among eligible households in the community is the penetration of individual conservation measures among participating households. It is probable that some households participating in the program will not be treated with conservation measures targeted under program specifications, whether due to the structural characteristics of the residence or to the preferences or attitudes of residents. This will result in limitations on the extent to which treatments may be applied in spite of the occupants' fundamental willingness to participate in the program. Moreover, these barriers to the implementation of various measures could well impose significant limitations on the degree to which a conservation program offering a specified package of measures can reach the energy and capacity savings which would accompany universal application of measures.

This evaluation area addresses this issue by specifically identifying the levels of measures actually implemented in participating households. In addition, this series of evaluations will address two other, closely related issues: the nature and effects of barriers which impede application of the total package and the statistical analysis of the effects on household energy

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and Supply of Service.

[8]Published by French et al. (1985). Regional Adaptation of Results: The Transferability Study.

[9]Results published by Hirst and Goeltz (1986). Dynamics of Participation and Supply of Service.

[10]Analysis not performed.

[11]Results published by Hirst and Goeltz (1986). Dynamics of Participation and Supply of Service.

savings of different treatment levels as imposed on the Project by these barriers.

This evaluation component analyzes activities within the processes designated as "treatment" throughout the remainder of the evaluation description. In recognizing that program participation and the installation of full treatment measures are not perfectly correlated, it suggests sources of variation within the treatment process. Figure 1 graphically depicts the nature of this process.

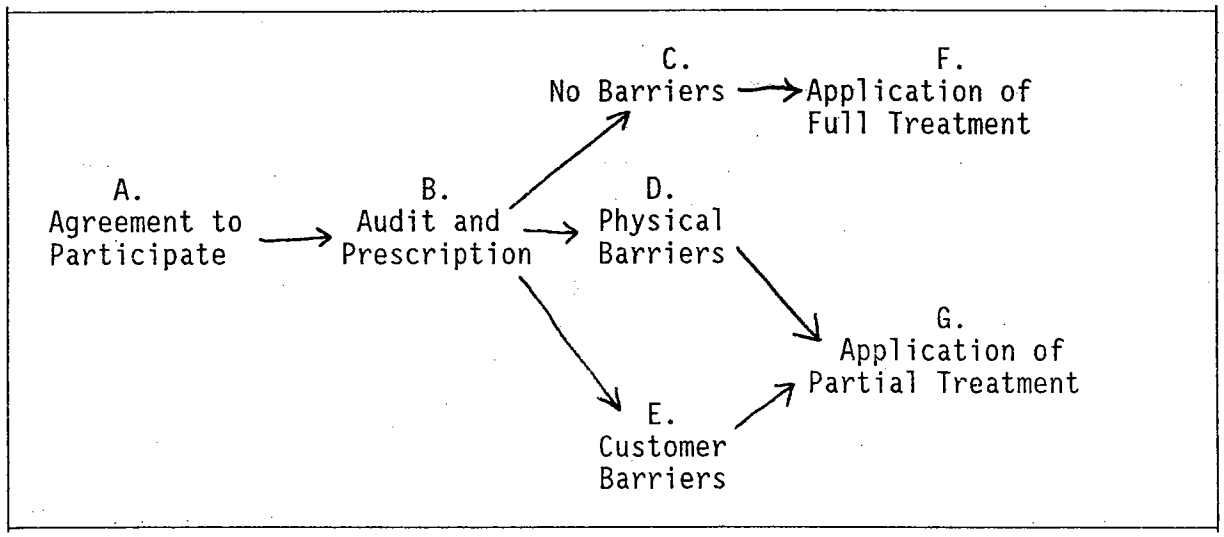

Figure 1. Treatment penetration flow diagram.

As shown in the diagram, three possibilities arise at or after the time of the audit. If no barriers are recognized, the prescription and application of full treatment can proceed. A second alternative entails the existence of physical barriers to the installation of all program measures: this situation would lead to the application of a set of measures of less than programmatic intensity. Finally, members of the household may object on some grounds to some or all measures: again, this situation would lead to the application of a treatment other than that called for by the program. Since program-induced effects on consumption and demand are likely to be reflective of the levels of measures actually installed in residences, it is reasonable to anticipate that these variations in treatment would be accompanied by variations in effectiveness.

The evaluation process supporting this series of question is primarily one of analysis. Where most other evaluation components necessarily entail data gathering strategies which in turn necessitate design specifications, this series of analyses bears no such requirement. Instead, the evaluation focus is primarily one of modeling the incidence and barriers to the various measures, based solely on empirical observations as evidenced among program participants.

As suggested in Figure 1, structural and customer barriers to the application of specific measures will likely become known after the initial agreement to participate in the Project and before the actual installation of the treatment. Accordingly, barriers and their effects on the program's application can be documented by the program representative to whom the barrier first becomes apparent.

As noted above, anticipated barriers are of two types. Structural barriers are characteristics of the residence which preclude the installation of a specific measure or else permit its application to a degree less than that specified by the program. An example would be the inability to install R-49 ceiling insulation because of a roof line which physically permits only R-30. The recording of this parameter and its effect on the treatment of the residence would constitute a data point for this evaluation phase. Aggregated, these data for all households would suggest the degree to which specified program practices could not be met, the reasons why they could not, and the effects of the barriers on the program.

Customer barriers represent a similar case: however, while these impediments may lead to less than specified treatments in some cases, it is also reasonable to anticipate that customer actions may lead to greater levels of treatment to other residences than are specified in the program. In either case, such departures from specification would lead to inclusion as a point of observation.

Residences evidencing both types of barriers will contribute variance to the programmatic treatment levels applied to the community's residences. Additional variance will be contributed through the levels of conservation treatments applied to residences before the program and "beyond program" levels or measures implemented at the option of (and cost to) residents. As pretreatment conditions will be physically measured as part of the audit procedure, and posttreatment levels similarly assessed through quality control audits, precise measures of program-related treatment levels will be available.

Approach to analysis of penetration of measures

Together, these three types of data -- relating to physical barriers, customer barriers, and variations in treatment levels -- comprise the basis for analytical work addressing three focal questions. The quantification of effects imposed on the program by physical barriers entails a series of frequencies documenting the incidence of each such impediment encountered during the course of the project: summed and related to the total number of residences eligible for project treatment, these data can also provide the basis for producing saturation estimates. Similarly, customer barriers may be aggregated as a measure of the degree to which this class of influence affected the project.

The consequences on consumption savings of differences in treatment levels will be addressed through the application of correlational and structure search techniques, or the equivalent.

Sample design

Whether through the characteristics of residences as ramified through structural barriers or pre-existing conservation measures, or through the expressed preferences of householders, households will self-select into the various groups addressed by these evaluational analyses. As no data currently exist which can be used to estimate the extent to which treatment variation will be encountered, it is not possible to specify the precision with which estimates may be developed.

Variables to be employed and data sources

The variables to be employed in these analyses are fewer in number than those of most other evaluation components. As suggested above, structural barriers will be documented by the energy auditors who inspect residences prior to treatment or by quality control inspectors who audit to ensure compliance: these same people will document, through inspection, the effects of the various barriers on the program's weatherization package. Similarly, customer barriers and their effects on the treatment package will be documented by program auditors and inspectors. Where conservation measures have been applied to a residence prior to the program, auditors and inspectors will physically measure pre-existing and posttreatment levels, respectively, and program-related treatments will be represented by the differences between

these values. Finally, the electrical consumption will be obtained from the files of the electric utility serving each customer.

Research products

Information which will be developed through these analyses will include the following:

1. Identification and measures of frequency with which physical barriers to the application of the total treatment package are encountered.[12]

2. Measures of the effects of physical barriers on the application of programmatic conservation measures.

3. Identification of pre-existing levels of conservation measures.

4. Description and frequency of customer options for "beyond program" levels and measures (at cost to customer).

5. Identification and measures of frequency with which customer barriers to the application of the total treatment package are encountered.

6. Measures of the effects of customer barriers on the application of programmatic conservation measures.

7. Descriptive statistics of residences in which various types of structural barriers are found to exist.

8. Estimates of the effects on energy savings of incremental additions to the conservation treatment of households.

[12]Results of analyses 1-8 published by Goeltz and Hirst (1986). Residential Retrofit Measures: Recommendations, Installations, and Barriers.

Comparison of Heat Loss Methodologies

Evaluation design

Critical decisions and assertions regarding the effectiveness of conservation measures rest upon the reliability and accuracy of the heat loss methods used in their evaluation. Controversy over the assumptions, structure, and use of various methods has resulted in the promotion of several models. The project provides an opportunity to gather sufficient data from a sample of structures to compare the most popular of these models. Additionally, it provides opportunities to refer to the substantial base of consumer, structure, and community observations to understand and explain variations from the results of these models due to behavioral and other influences.

This evaluation objective, like others in the project, will utilize information from two sources; namely, the basic energy audits performed on all structures, and data from a sample of structures that will be extensively monitored and audited. The latter sample will consist of all of the structures sampled for the load data study, and will make available to the analysis subhourly[13] load and internal temperature data collected from residences. It will also make available structure-specific data on consumer characteristics that will facilitate explanation of observed deviations of results from those expected.

Approach to comparison of heat loss methodologies

Analysis of the alternative models are naturally divided into two types: building simulation and post hoc analyses of results. It is anticipated that sufficient data will be collected to permit building simulations using alternate modeling techniques. Two models are to be compared based on the observed and expected simulation results. To the extent that there are differences between the observed and the expected results or the different simulations, post hoc analyses of these differences will be necessary. Limitations on findings are indicated.

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[13]Homes were monitored at the fifteen-minute level.

Sample design

Two data collection vehicles support this analysis. The first is a sample selected from potential project participants for extensive monitoring and auditing. This sample is identical to that selected for the Capacity and Diversity Effects study (see Section 4). Second, a detailed energy audit was conducted for a census of all project participants. This audit encompasses all of the variables generally required in the Bonneville audit program as well as selected consumer characteristics questions specific to the Project.

Variables to be employed and data sources

Data for these analyses is provided from building audit forms and special studies of a sample of 320 structures. The building audit forms are used to audit all participants' structures. These forms include all of the information presently collected on Bonneville audit forms plus some additional consumer characteristics data added specifically for this Project. Certain additional data is collected at each site to facilitate subsequent analyses of solar retrofit suitability (e.g., solar orientation as determined by a pathfinder study, roof angles, and photos or diagrams of each structure).

The samples of approximately 320 structures include the basic energy audit results plus interview items as well as the on-site recording of the following:

* Total electric load (subhourly).
* Space heating system electric load (subhourly).
* Water heating system electric load (subhourly) or wood heat contribution (subhourly).
* Test of space heater thermostat calibration and sensitivity.[14]
* Blower door test (25 homes only).

This data is intended to permit a variety of building simulations and heat-loss model evaluation. It may, however, be insufficient to satisfy certain questions of marginal interest such as how much energy is used to humidify/dehumidify homes, what impact does weatherization have on humidity in a structure, how much energy does the structure use under vacant but

[14]This test was not performed.

normal heating conditions, and so on. These additional analyses would require additional instrumentation, monitoring, and recording (i.e., multiple thermometers in the heated space, thermometers in the buffer spaces, submetering of humidity and humidifier/dehumidifiers, and tests of vacant houses during the heating season with the heating system in normal operation modes). Such additional instrumentation has not been planned.

In addition to these site-specific data collection activities, local climate data will be collected at three microclimate meteorological stations using subhourly recording intervals comparable to those used for load recording. Six weather data elements are anticipated.[15]

Anticipated weather data elements

Outdoor dry-bulb air temperature

The dew point temperature of the outdoor air will be measured at the main weather station. This parameter will help to account for latent heat loss effects due to infiltration. The absolute humidity of the air is of particular interest. This parameter will be derived by the measurement of dry bulb temperature, barometric pressure, and dew point temperature. A dew point sensor will be installed at the main station to collect this data and will be enclosed in a self-aspirating radiation shield.[16]

Wind speed and wind direction

Both wind speed and wind direction will be measured at each of the three weather stations. Wind-induced infiltration losses are one of the largest heat loss mechanisms affecting residential heating loads. Due to the considerable and unique influence of the Columbia River Gorge on the wind characteristics in the Hood River area, the wind data collected for the Project assumes an even greater importance. The wind speed and direction sensors will be installed at a ten meter height above ground level at each weather station.

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[15]Only temperature, wind speed, and wind direction were measured at the third station.

[16]Relative humidity was measured in place of dew point temperature.

Soil temperature

Soil temperature has a considerable effect on heating loads for homes built with basements or with a slab-on-grade floor system. Consequently, soil temperature measurements will be taken at the main station at depths of 4, 20, and 40 inches below grade.

Barometric pressure

The barometric pressure will be measured only at the main weather station since this parameter will not vary appreciably within the study area.

Solar radiation data

Solar radiation data will be measured only at the main weather station since little significant variation is expected to occur within the study area. Instrumentation to measure solar radiation will consist of a normal incidence pyrheliometer to measure direct, or beam radiation and a pyranometer to measure horizontal global radiation. These data are used to produce reduced data consisting of direct and diffuse radiation components.

Research products

Results supplied by Pacific for synthesis into the comprehensive final report include the following:[17]

1. Comparison of average building simulations with each other using standard inputs and two alternative models.

2. Comparison of alternate building simulations with observed behavior using standard inputs and two models.

3. Supplementary comments and data.

[17]Results also published by Yoder (1987). Comparison of SUNDAY Model Predictions and Monitored Space Heat Energy Use.

Section 3: Feeder Study of Capacity and Diversity Effects

This phase of the project evaluation entails two parallel components, each designed to assess the impacts of the Hood River Project on selected load characteristics. In the first, a sample of households served by a single feeder will be end-use monitored while the feeder itself will be load monitored as well: this phase of the evaluation will address capacity and diversity effects, and is denoted in subsequent discussion as the "Intra-Feeder Evaluation." In the second, all feeder lines serving the project area will be monitored in order to develop estimates of program effects on aggregated load characteristics as residences in areas served by the various feeders are successively treated under the program: this component will be referred to as the "Inter-Feeder Evaluation" in subsequent discussion. Each component of the project will be separately addressed in the discussion to follow.

Intra-Feeder Evaluation

Evaluation design

The assessments of capacity and diversity effects will each draw from a modified non-equivalent control group design (Campbell and Stanley, pp. 47-50), as reflected in Table 3.

Table 3. Intra-feeder evaluation of capacity and diversity effects non-equivalent control group design

Analysis Group	1982/83		1983/84
Space and Water Heat Customers	O	X	O
Basic Service Customers	O		O
Feeder	O		O

O = Observation
X = Treatment

Three sets of observations will be employed in these analyses. First, a sample of households with electric space and water heat will be end-use monitored before and after the auditing, treatment, and quality control inspection of their residences. Second, a sample of Basic Service Customers will be monitored for total load throughout the period of end use metering noted above. Finally, the feeder line itself will be monitored during the same time frame.

Load metering will develop hourly demand data for all three sets of observations for the duration of the project. As individual residences and the feeder will not have been monitored prior to the inception of the project, no historical data will be available.

A third focus of this evaluation component lies in estimating the effects of the program on aggregated load characteristics as monitored on the feeder serving the area. While requiring data of the type which will be collected through the design depicted in Table 3, this phase of the task will be essentially empirical, and consists of statistical estimation of the strengths of association between programmatic effects on the loads of individual households and those of the feeder serving them. General relationships between variables are shown in Figure 2.

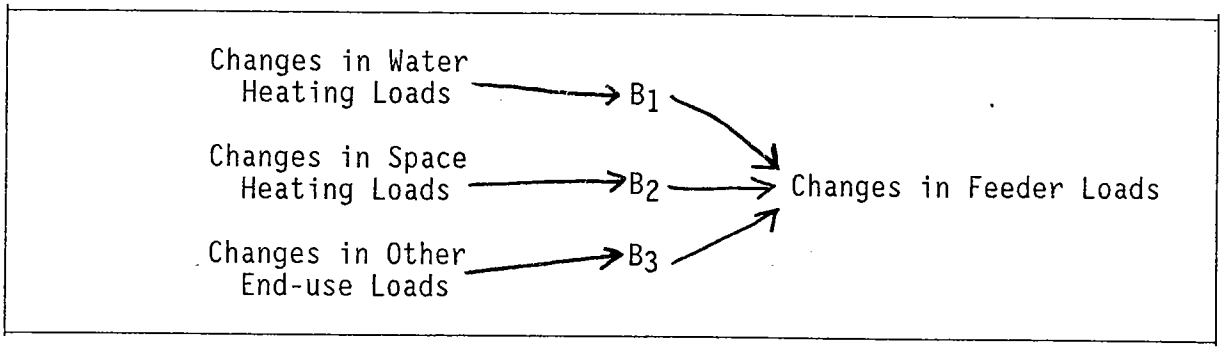

Figure 2. End-use/feeder load relationships.

This figure depicts changes in feeder loads as resulting from changes in the loads associated with the various end uses it serves. As an outgrowth of this causal relationship, changes in feeder loads may be modeled in part as functions of programmatically-induced changes in water and space heating loads in the service area; B_i, then, represents the effects of household-

specific variation on feeder variation. This analysis focuses on estimating the values of B_i.

Approach to intra-feeder analysis

Analysis of the diversity effects of the program will incorporate the load data of the electric space and water heating sample and the basic service sample. An issue in this assessment is the degree to which the coincidence of individual electrical demands among these customers is altered through their participation in the program. The pre- and posttreatment end-use metering, in place on these customers' residences, will additionally permit identification of how individual end uses contribute to any changes which are identified. Analyses will focus on comparisons of load characteristics associated with the two classes of customers before and after the treatment of eligible residences. It is expected that all monitored loads among treated households will decrease to a greater degree than will the total load of basic service customers: moreover, it is anticipated that space and water heating loads will reflect greater program-related change than will the total loads of either group.

The evaluation of capacity savings will employ the same general approach, but will focus on a different dependent variable. While the evaluation of diversity effects addressed program-related effects on the coincidence of customer energy use, the assessment of capacity effects addresses program-induced changes in the rate at which electrical energy is used by individual customers or groups of customers. As with the assessment of capacity, treatment effects on load will be compared to differences in load observed among basic customers who were not exposed to program treatments: net differences will be attributed to program effects and other statistically controllable differences between groups, and to weather.

In both sets of analyses, the comparison group of basic service customers is designed to provide a measure of the general effects on the community of the communication associated with the Hood River Project. It is reasonable to anticipate a "bandwagon effect" in which customers' awarenesses of electricity use will be sharpened. Since those without electric space or water heat will not be eligible for the application of conservation materials, systematic alterations in demand levels occurring during the project period may reasonably be attributed to an effect of this type.

Programmatic effects on space and water heating loads will rely on comparisons of pre- and posttreatment demand characteristics of the individual residences, with statistical controls applied to represent the influences of other variables.

Analysis of the third evaluation issue -- the contributions of changes in end-use loads to changes in feeder loads -- is well suited to multivariate correlational techniques by virtue of their abilities to identify treatment effects while statistically controlling the effects of other quantifiable influences. As in other bodies of analysis, control variables will represent selected characteristics of the residences and householders observed through the metering of loads.

Sample design

The sampling scheme for the Intra-Feeder Evaluation involves a two-stage process in which the feeder is first identified, followed by the selection of customers for monitoring. Due to the cost of load monitoring equipment, the feeder study will be confined to a section of single feeder.

The feeder will be selected in accordance with a number of criteria. While it is unlikely that a "typical" feeder exists, it is nonetheless pertinent to select one which is optimally consistent with criteria relating to types and number of customers served, length, urban/rural mix, and age and rate of growth in served housing stock. In addition, the operation characteristics of the line, including load size, associated dimensions, and constancy of configuration are important.

Customers to be monitored will be selected through random sampling applied to customers with electric space and water heat. The sample size to be achieved with space and water heating customers should be sufficient to ensure 90 percent confidence and 10 percent precision with respect to changes in consumption associated with the program's conservation treatments: a sample size of approximately 325 space and water heating customers. Approximately 100 basic service customers will be monitored for total loads to establish a baseline against which the experimental groups' experiences can be gauged. One hundred observations in this group would be sufficient to permit comparisons of mean differences with five percent precision and 90 percent confidence (with an assumed effect size of 0.40).

Variables to be employed and sources

The principal variables to be addressed in this evaluation relate to load characteristics, including level, timing, duration, and coincidence. These values will be operationalized through load recordings of the feeder line and the samples of customers' residences.

Measures to be treated as statistical controls relate to such influences as weather and the characteristics of customers, their residences, and their inventories of electrical appliances. These measures will be obtained from surveys as well as through the audits and posttreatment inspections of treated households.

Research products

The products of this series of evaluation steps will include the following:

1. Measures of residential load shapes, including those for electric space and electric water heat, other end uses as a group, and total.[18]

2 Measures of differences in residential load shapes for basic service customers and for all electric customers.

3. Measures of end-use-specific contributions to aggregate load as measured on feeder lines.

4. Measures of diversity among customers with electric space and water heat, among customers with basic service only, and between members of both groups.

5. Measures of programmatic effects on household load shapes.

6. Measure of programmatic effects on feeder load characteristics.

7. Measures of campaign effects on the load characteristics of households ineligible for treatment under the program.

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[18]Results of analyses 1-7 published by Stovall (1987). Load Analysis.

Inter-Feeder Evaluation[19]

Evaluation design

As noted elsewhere in this document, the weatherization of residences will proceed on a feeder-by-feeder basis. This approach invites comparison between feeders with respect to aggregated load characteristics, and is well suited to a modified multiple time series design (Campbell and Stanley, pp. 55-57), as follows.

Table 4. Inter-feeder load evaluation

	Time Period											
	1	2	3	4	5	6	7	8	9	10	11	12
Feeder #1	X	0	0	0	0	0	0	0	0	0	0	0
Feeder #2	0	X	0	0	0	0	0	0	0	0	0	0
Feeder #3	0	0	X	0	0	0	0	0	0	0	0	0
.						.						
.						.						
.						.						
Feeder #12	0	0	0	0	0	0	0	0	0	0	0	X

O = Observation
X = Treatment

In this design, recipients of the treatment in a given time period are compared to those who were not treated during that period with respect to changes in a focal variable. Net differences are attributed to the treatment condition and to other variables which might not be equivalent among the various groups: with the latter statistically controlled, the effects of the treatment can be estimated. All units of observation serve as an experimental group once, during the course of the project, and as bases of comparison at other times.

[19]This section of the Project was subsequently dropped due to cost.

This analytical approach is not without weaknesses. As suggested above, the body of customers served by each feeder are likely to be different from those served by other feeders. Differences in urban/rural mix and commercial and industrial uses, for example, undoubtedly distinguish the various feeder-defined areas. Additionally, the tendency for socioeconomic differences to be ramified in patterns of residential location suggests that treatment effects will vary by feeder. To a great extent, however, these influences may be statistically controlled. These issues notwithstanding, it is felt that the findings of these analyses will be valuable, both for their contributions to an overall understanding of treatment effects and for the insights they will provide into determinants of aggregated load sensitivities to conservation treatment.

Approach to inter-feeder analysis

As with other components of the project, this question essentially addresses the identification of differences in selected load characteristics associated with the Hood River Conservation Project: included among these characteristics are the level and timing of loads. As noted above, however, it is reasonable to assume that differences in attributes of the various feeder lines and the areas they serve will influence these differences, and so will require the application of statistical controls to the analytical technique. As a result, it is envisioned that a technique based on the principles of analysis of covariance will be employed in analyses undertaken in pursuit of this question.

Sample design

The sample design for this evaluation area is straight-forward. Twelve feeder lines serve the project area -- seven in the Pacific service area and five in that of HREC -- and all will be monitored for load throughout the duration of the project.

Survey designs will permit the estimation of such measures as appliance saturations and socioeconomic variables within established precision parameters at the level of the individual feeder. This requirement will be addressed in greater depth in subsequent discussions of project surveys (see Section 7).

Variables to be employed and data sources

The dependent variables to be employed in the analyses reflect load characteristics, including peak level, duration, and timing. All will be operationalized through the hourly kW load data collected through the monitoring of feeders. The treatment condition of each feeder will be derived from the project's managerial files, which will include the timing and extent of weatherization completed in each feeder's service area. Covariates will include measures of other variables which might affect feeders' load characteristics. Measures which might be addressed as covariates include the mix of commercial and industrial customers (taken from utility records), the urban/rural nature of the service area, age of housing stock, appliance saturations, and demographic measures (taken from Project surveys).

Research products

Research products for the inter-feeder analysis will include:

1. Effect of treatment on aggregated load shape as represented by feeders.

2. Measures of load characteristics at feeder level -- level, duration, and timing.

3. Measures of inter-feeder diversity.

4. Effect of treatment on inter-feeder diversity.

Section 4: Process Evaluation of the Hood River Conservation Project

The process evaluation has two separate areas of focus. The first concerns project implementation, and the second concerns evaluation of the effectiveness of the marketing/communications effort.

Assessment of Program Implementation

The assessment of program implementation is the story of what was planned as the Hood River Conservation Project, and how plans were implemented, modified, and subsequently carried out. In part, the question addressed in process evaluation is "whether...(the)...program was implemented according to its stated guidelines" (Bernstein and Freeman, p. 18). Additionally, the process evaluation is the story of the project, a narrative rooted in project experience to be of value in understanding the project and designed to be useful to other utilities considering community approaches to conservation.

Evaluation design

Process evaluation is designed as a case study, primarily qualitative in nature, to be based on historical records, the community assessment, interviews, and the experience of project personnel and management.

Approach to assessment of program implementation

The analytic approach will involve application of case study methods. Primarily, this will involve analysis and synthesis of available records of project progress, obstacles, and emergent developments which impinged upon the course of the project. Quantitative results from other phases of the evaluation plan will be qualitatively assessed and integrated into the project story.

Sample design

All survey material (see Section 7) will be available for use in the process evaluation, and will be drawn on selectively. In addition, a separate time-series sample of community perceptions and knowledge of the project

and a supplementary sample of interviews with project personnel over time is proposed. The community perception survey will be a systematic random sample mail or phone survey of a small number or residences every two months for the duration of the project. The project personnel survey will be designed as a systematic sample of time intervals covering various personnel levels.

Variables to be employed and data sources

All project records will be available. Attitudinal information will be drawn from surveys (see Section 7), the community assessment, and other observations and experience.

Research products

Research products from the assessment of program implementation include the following:

1. "The Hood River Story" -- a narrative monograph on the history and experience of the conservation campaign in Hood River.[20]

2. "The Community Conservation Campaign" -- a narrative monograph written in the form of a guide for utilities in implementation of a community approach to conservation. [This product was later incorporated into "The Hood River Story".]

3. "Conservation Constraints" -- brief paper describing negative and positive effects stemming from the size and intensity of the program in Hood River. This paper may be incorporated in document 1 or 2.

4. "Report on Staff and Community Perceptions" -- brief summary report derived from staff interviews and community interviews over time, tracking changes in perceptions. This paper may be incorporated in document 1 or 2.[21]

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[20]Published by Schoch (1987). Volume I: The Hood River Story -- How A Conservation Project Was Implemented, based on Flynn-Brown (1986) Process Evaluation and Philips et al. (1986) Field Weatherization Logistics.

[21]Unpublished report.

Evaluation of Communication Media and Techniques

Evaluation of the marketing/communications case study objectives of the project is approached quantitatively through assessment of the communications package recommended by the marketing consultant. Although advertising materials are yet to be developed and the communications package is not yet defined as to recommended media and techniques or sequencing of elements, the evaluation plan outlined below should be flexible enough to accommodate the recommended package. Two tasks are addressed in the evaluation: evaluation of the communication package as a whole, and evaluation of communications elements.

Evaluation design

The evaluation design[22] proposed for investigation of the effectiveness of the communications package requires selection of two feeders for simultaneous program implementation. One feeder would be the focus of communications "treatments," while the second (serving as a control) would receive no communications other than general messages regarding the program available in the local newspaper, on the local radio station, and in general conversation and community interaction. Residences on both feeders would be simultaneously approached by auditors, and the criterion variable would be acceptance of audit.

The design for two feeders (Campbell and Stanley, p. 55) is shown in Table 5. As is indicated by the "R" in this figure, randomization of "treatment" is indicated before implementing the communications package. In other words, customers on each of the two selected feeders must be assigned, using randomizing procedures, to either of two groups within the feeder. The "treatment," X, is the entire communications package recommended by the marketing consultant. Observations are taken before the application of the package (simultaneously) in "Sample 1" of feeders 1 and 2; the communications package is then implemented in both "Sample 1" and "Sample 2" on feeder 1; and observations are taken after the conclusion of the communications effort on "Sample 2" of feeders 1 and 2 (simultaneously).

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[22]This design was not implemented in the project since community social interaction was high and invalidated a feeder-by-feeder approach.

As noted, two feeders are required for evaluation of the package as a whole. Both feeders plus perhaps three additional feeders can be used in the assessment of package elements.

Table 5. Two feeder separate-sample pretest-posttest control group design for communications package evaluation

Analysis Group	Randomization	Communications Package		
Feeder #1, Sample #1	R	O	X	
Feeder #1, Sample #2	R	-	X	O
Feeder #2, Sample #1	R	O	-	-
Feeder #2, Sample #2	R	-	-	O

R = Random assignment
O = Observation
X = Communication Package

The evaluation of package elements may be approached in either of two ways, depending on the marketing plan adopted.

If the marketing plan recommended by the marketing consultant and adopted for the project emphasized a series of techniques such as door hangers, letters, neighborhood meetings, etc., and if the criterion variable chosen to operationalize a communications "success" is in the form of a "mail-in" card or phone request for an audit, then evaluation and sequencing of elements may be accomplished through a counterbalanced design (Campbell and Stanley, pp. 50-52), as shown in Table 6. In this design each residence on a feeder is approached with each element in the communications package, but with different sequencing of elements applied to different groups of residences on a feeder. The Latin square design has four communications elements and four analysis groups (as many analysis groups as "treatments", see Table 6), but the pattern could be extended and/or elaborated to fit the number of elements in the package developed by the marketing consultant and adopted by the program.

The emphasis on consumer-initiated action, in response to communications package elements, exemplified by Table 6, might be the focus of "stage 1" of a marketing plan. "Stage 1" might be applied only to certain feeders, with a different approach applied to other feeders.

Table 6. Within-feeder counterbalanced design for communications package element evaluation

Analysis Group	Time 1	Time 2	Time 3	Time 4
Group #1	X_1O	X_2O	X_3O	X_4O
Group #2	X_2O	X_4O	X_1O	X_3O
Group #3	X_3O	X_1O	X_4O	X_2O
Group #4	X_4O	X_3O	X_2O	X_1O

X_i = Element "i" of package
O = Observation

A second approach to evaluation of communications package elements would be appropriate for a marketing plan emphasizing customer response to auditor contact (this might be "stage 2" of a marketing plan). Auditor contact with residents of a home would likely supersede all other communications elements, and if communications precede auditor contact in planned sequences, and the criterion variable chosen to represent communications "success" is operationalized as decision to accept an audit in the context of auditor contact, the evaluation design shown in Table 7 would be appropriate. In this design, residences on a feeder are first assigned to groups based upon a randomizing procedure. As many groups are created as there are "treatments" (where sequences of elements may be considered as separate "treatments"), plus an additional group which serves as a control (Campbell and Stanley, pp. 25-34).

Repetition of this design across all feeders selected for evaluation of the marketing/communications case study objectives (perhaps five feeders) will provide information from different sections of the community, and averages of "success" rates across feeders will provide community averages with which to evaluate communications package elements.

Table 7. Within-feeder posttest-only control group design for communications package element evaluation

Analysis Group	Randomization	Treatment	Observation
Group #1	R	X_1	0
Group #2	R	X_2	0
.	.	.	.
.	.	.	.
.	.	.	.
Group #n	R	X_n	0
Control	R	-	0

R = Random assignment
X_i = Element "i" of package
O = Observation

Approach to communication evaluation

The evaluation designs selected lend themselves to an analysis of variance approach. In addition, the analysis will employ bivariate correlation matrices, stepwise regression, hierarchical multiple regression, and discriminate analysis. Survey information (see Section 7) will be incorporated in application of these techniques.

Sample design

Sample design will begin with the selection of two feeders for the communications package evaluation and the additional feeders (perhaps five in all) for evaluation of package elements. Analysis group sizes can be determined once the marketing/communications plan is adopted, and random assignment may be performed in close consultation with project administration.

Variables to be employed and data sources

The criterion variables for this analysis will be "success" indicators. Indicators of "success" will be selected from the following: customer initiated request for audit, customer acceptance of participation in audit with auditor contact, and customer participation in program weatherization following audit.

Independent variables to be used in the analysis will consist of one or more of the following: communications package as a whole, elements of the communications package, and attitudinal variables; reason-analysis variables, demographics and dwelling characteristics from audit records and surveys (see Section 7).

Research products

Research products of the marketing communications case study include the following:

a. Report on the effectiveness of the communications package.

b. Assessment of the effectiveness of elements and sequences of elements in the communications package.

c. Recommendations for future marketing/communications efforts, referenced to empirical findings in the present study and to relevant conservation marketing/communications literature.

Section 5: Synthesis of Results and Final Report

The preceding discussion in the evaluation section has been oriented to developing information and findings relating to specific issues, each of which contributes a piece to the overall evaluation of the Project. While each of these components serves a necessary function in the overall assessment of the project, the pieces do not form a whole until they are brought together and assessed as a group. The synthesis of results and final project report will perform these functions for the Hood River Conservation Project.[23]

A similar process is necessary in aggregating the resources which will be necessary to undertake and complete the project. This phase of the evaluation will entail the compilation, assignment, and summing of resource costs, and additionally the critical assessment of how each cost item contributes to the project component with which it was associated and the project as a whole.[24]

A critical component in the assessment of project effects and resource requirements relates to the process evaluation of the project. Among other products, the process evaluation will address how the project's progress was affected by influences associated with the group implementing the Hood River Conservation Project, the community into which the project was introduced, and the interaction of these two bodies. This is a highly important component in the larger evaluation process.

It is reasonable to anticipate that the project will command greater attention than have other conservation programs available to the consuming public because the project will entail the intensive communication of conservation and project-related information to individual and organization members of the community. As a result, the alignment of community organizations behind or against the project can bear strongly on its outcome. Similarly, tasks completed well or poorly will likely become widely known as the program unfolds. In these instances and in others like them, the ultimate success of the project may well be affected by conditions which are only indirectly associated with the project itself. For these reasons, the synthesis and

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[23]Published by Hirst (1987). Cooperation and Community Conservation: The Hood River Conservation Project.

[24]Published by Philips et al. (1987). Cost Analysis.

reporting of the project's evaluation will necessarily be conditioned by the nature of the processes which surround its implementation and conduct.

In general, the final report will be comprised of three broad sections. First, the processes and results of the individual evaluation components will be reported: included in these descriptions will be the sources and processes through which data were obtained, descriptions and results of evaluation analyses, and findings. Second, the report will address the process and results of drawing findings together in support of conclusions arising out of the project: this phase of the report will encompass the considerations outlined above. Finally, the report will address implications of the project for other applications: important components of this part of the report include not only the identification of which implications are suitable for use in other spheres of activity and consideration, but also those which are not.

Section 6: Definitions of Variables to be Used in Analysis

The exact specification of variables to employ in the various analytical applications will remain unaddressed until a later point in the project's development. Nonetheless, the discussions of evaluation procedures which preceded identified a number of measures and types of variables which would likely be employed. This discussion draws these measures into a single location and identifies them in terms of general definition and likely source. Two classes of variables will be addressed: those planned for use in the evaluations of program effects, and those to be employed in the process evaluation of the Hood River Program. Each of these will be discussed individually in the text which follows.

Program Effect Evaluation

Variables and types of measures identified in association with the various evaluations of programmatic effects include those shown in Table 8.

Table 8. Effect evaluation variables and planned sources

Variable	Source
Treatment Levels	Auditors' measurements, quality control inspectors' measurements
Treatment Condition	Hood River Conservation Project records
Consumption	Utility billing records
Load Characteristics: Customers	Load monitoring of a sample of basic service customers, end-use load monitoring of a sample of customers with electrical space and water heat
Load Characteristics: Feeder	Load monitoring of feeder lines
Customer Barriers, Effects	Energy consultants and quality control inspectors

Table 8. Effect evaluation variables and planned sources, cont'd.

Physical Barriers, Effects	Energy consultants and quality control inspectors
Demographic Measures	Surveys
Weather	NOAA records
Indoor Temperature	Monitoring of inside temperature of residences in end-use monitoring sample

Treatment levels

Treatment levels represent the conservation measures actually applied to a residence during the course of the project. Treatments will be of three general types: weatherization, water-heater wraps, and heat pump space-heater installations. Water-heater wraps and heat pump installations will be dichotomous measures, reflecting whether or not either measure is applied to a residence through the project.

Weatherization measures may reflect differences of degree: for this reason, three component indexes are relevant for each treatment measure in the weatherization package. The first involves weatherization measures found in the home and measured by the energy consultant at the time of the structure's audit for program treatment. The second index represents the treatment levels found and measured to be in place after treatment of the home under the program. A third index, derived from the difference between pre- and posttreatment measurements, represents the treatment levels actually attributable to the Hood River program.

Treatment condition

This variable is a dichotomous measure reflecting the presence or absence of project-related conservation treatments in a household or, alternatively, in aggregations of households served by a feeder. These data will be maintained on a current basis in project files.

Consumption

Measured in kWh, electrical consumption represents the quantity of electricity used by households during selected time frames. Consumption data will be drawn from the customer accounting records of participating utilities for months comprising the project period. Additionally, historical consumption data as available will be used to augment what developed during the course of the project.

Customer load characteristics

Measured in kW and documented in one-hour time frames, individual customer loads will be monitored among two samples of customers served by a selected feeder. First, a sample of electrical space and water heating customers will be monitored with four-channel recording equipment: space heating, water heating, and total loads will be recorded along with indoor temperature. In addition, total load only will be monitored among a sample of customers with neither electrical space nor water heat. Three load characteristics of individual residences will be documented: the magnitude of load (measured in kW), the duration of peak load (measured in hours and reflected in load shapes), and peak load timing (reflecting the time of peak demand). In addition, the degree of concurrence of demand peaks among individual customers -- diversity -- will be assessed.

Customer barriers and effects

It is anticipated that various aspects of the measures included in the project's conservation package may lead certain customers to resist application of the full program to their residences, or to contribute to treatment cost and exceed the measures specified by the program. These cases will be documented by program auditors and quality control personnel as they become known, as will the nature of the customer barriers and the effect on conservation measures installed in the residence.

Physical barriers and effects

To be chronicled at the time of the audit and/or at the time of post-treatment quality control inspection, physical barriers represent characteristics of the residence itself which preclude in part or in total the appli-

cation of a weatherization measure. Physical barriers will be documented in terms of the characteristic actually precluding full treatment application and the degree to which the weatherization measure was affected.

Demographic variables

Demographic measures to be used in project analyses have yet to be selected but will likely include the number of residents and selected measures of socioeconomic status. These values will be obtained through surveys of households.

Weather

Focusing primarily on temperature, weather data will be obtained from NOAA records.

Indoor temperature

Important as a variable through its direct linkage to occupant behaviors, indoor temperature will be documented through temperature sensors placed in the residence and linked to load recording equipment installed as a part of end-use metering. Resulting data will provide hourly measures of residential temperatures.

Process Evaluation

Variables to be used in assessment of program implementation and in evaluation of communication media and techniques include those in Table 9.

Table 9. Process evaluation variables and planned sources

Variable	Source
Treatment Levels	Auditors' measurements, quality control inspectors' measurements
Demographic Variables	Surveys
Historical Data	Project records, community assessment, interviews, experience of project management and personnel
Community Perceptions	Community perception survey (see Section 7)
Conservation Constraints	Project records, project management information system reports, experience of project management and personnel, contractor and/or subcontractor interviews, quality control inspectors reports
Planned Implementation	Project documents, proposal, records of planning sessions, Bonneville guidelines, contract, interviews with project management
Actual Implementation	Experience and observation (see Historical Data, Community Perceptions, Conservation Constraints, above)
Communications Package	The communications package will be developed by a marketing/communications consultant, and subsequently a modified version of the recommended package will be adopted by project management
Communications Elements	Conservation package

Table 9. Process evaluation variables and planned sources, cont'd.

Consumer Initiated Response	Customer request for audit, possibly stimulated by elements in the communications package, prior to auditor contact
Customer Auditor Response	Customer decision to participate in audit, taken in response to auditor contact
Success	Success will be defined as: customer initiated response of request for audit; customer auditor response of request for audit; customer participation in program weatherization following audit. Each definition of this criterion variable will be employed in parts of the analysis. Derived from customer contact records, auditor reports, project weatherization records
Sequence	Particular sequences of communications elements may be defined as elements, if recommended by marketing/communications consultant and/or adopted by project management
Attitudinal Measures	Surveys
Reason-Analysis Variables	Marketing Surveys
Dwelling Characteristics	Surveys and audit records

Section 7: Outline of Surveys in the Evaluation Plan

Six separate surveys will be employed in the project evaluation. First a "pretest" survey will be used to develop baseline attitudinal measures before or during the initial stages of project implementation. Second, an audit survey will be administered to all people who accept the weatherization audit. This survey will be extended by addition of a supplementary set of questions selected as key items from Bonneville's planned 1983 Pacific Northwest Regional Survey. Third, market surveys will record customer perceptions and attitudes related to reasons for participating or not participating in the audit and weatherization elements of the Hood River Conservation Project.

Finally, a "posttest" survey will be administered to register shifts in conservation attitudes and perceptions during the time the project is operative in Hood River. In addition, two supplementary surveys are planned. The first will be a time series sampling of community perceptions, and the second will involve interviews with project management and staff. Each survey sample will be designed to accomplish information objectives at defined levels of statistical significance and statistical power at minimum cost (Cohen 1977).

Pretest Survey

The pretest survey will be a short (4-5 page) mail survey administered to a sample of the Hood River community as well as to the two comparison communities and to the PNW/Pacific Random Sample. The focus of the survey will be on conservation attitudes and is designed to produce a preprogram baseline for the Hood River community. Administration of the same survey in comparison communities will (in conjunction with data from the posttest survey) permit measurement of changes in attitudes as well as document the emergence of a conservation ethic and reported behaviors. The PNW/Pacific Random Sample (which may be designed as a stratified random sample) will demonstrate the representativeness of individuals in the Hood River community and the comparison communities with respect to Pacific's customers in the Bonneville region.

Audit Survey

The audit survey will consist of standard questions required for performance of a residential audit as well as key items selected from the Bonne-

ville planned 1983 Pacific Northwest Regional Survey. This survey will demonstrate how audited residence (and residents) in Hood River fit into the representative profile developed by the regional survey. Data will provide an inventory of appliances, use patterns, and dwelling characteristics. Information will be used in savings analysis, process evaluation, and costing.

The audit survey will have two components: first, a survey record for each audited residence (a near census sample of auditable residences, rather than a statistical probability sample),[25] and second, abbreviated surveys of other homes by feeder for use in the inter-feeder analysis (see Section 3).

Market Surveys

The market surveys will provide feedback on the communications and implementation aspects of the program. These will be short purposive surveys with separate versions for persons who accept or reject an audit, and for audited persons who accept or reject weatherization. It is currently planned that those who accept an audit (and those audited persons who accept weatherization) will be given a "drop-off/mail-back" survey (2-3) pages, but that an attempt will be made to interview in-person those who do not participate in audits and those audited who chose not to participate in weatherization. Information will be used in the communications evaluation (see Section 4). A reason analysis (Zeisel 1968) or similar approach will be used in instrument design.

Posttest Survey

The posttest survey parallels the pretest baseline, with perhaps a few additional questions. It will be administered in Hood River, the two comparison communities, and the PNW/Pacific Random Sample. The comparison groups will be used to factor out trends that may occur during the course of the Hood River Conservation Program in terms of conservation ethic and shifts in attitudes regarding conservation.

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[25]This was amended to include only those homes monitored for end-use consumption.

Community Perception Survey

The community perception survey will be used in the assessment of program implementation (see Section 4) and also in the evaluation of communication media and techniques. This survey will be conducted by phone every two months for the duration of the program and administered to small random samples of residences in Hood River. The survey will consist of a small number of questions (approximately 7-15) to track the trend of community perceptions of the program.

Staff Survey

A brief staff survey will be developed and administered in a time segment sample to protect staff and management. The management component of the survey will be accomplished by means of interviews at various stages in the project. The staff component will consist of a short series of questions on perceived efficiency, perception of customer response, and attitudes, to be filled out by the staff member without an interviewer present. The staff component may be supplemented by some interview data for the assessment of program implementation.

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Appendix
Selection Criteria for the Hood River Area

The study area was selected from alternative sites on the basis of general research criteria and logistical advantages. The principal selection standard was the ability of the study area to represent other communities of the Pacific Northwest. The following selection criteria were employed in judging potential sites:

1. The area is geographically delimited and definable.

2. There is a range of construction vintages, from new construction to pre-1945.

3. There is a diversified economy which is influenced by general economic conditions neither significantly more nor significantly less than other areas of the region.

4. The population is heterogeneous. That is, it includes a disparate mix of ages, sexes, and occupational involvement.

5. There are no unusual energy conservation programs or activities.

6. There are representative residential, commercial, and industrial sectors.

7. The area is served by both publicly-owned and investor-owned electric utilities.

8. There is a representative range of income levels and household sizes present.

9. The area is comprised of a representative mix of urban, suburban, and rural zones.

10. There is at least one community in the area with a population of at least 200 but not more than 25,000 population.

11. The area is sufficiently near Pacific Power & Light Company corporate headquarters to permit administrative access and technical support.

When these criteria were applied to Pacific's service area, Hood River, Oregon (county and city) met the criteria, while also meeting important logistical requirements. Further, the Hood River Electric Cooperative service area adjoins that of Pacific and is appropriately and easily included within the parameters of the program.

The recommended study area includes most of the 536 square miles of Hood River County, and has a population of approximately 15,065. It lies along the northern edge of Oregon, bounded on the north by the Columbia River, and is located approximately 45 miles east of metropolitan Portland.

The study area is served by Pacific and HREC. Pacific serves 5,093 customers: 4,046 residential, 760 commercial-industrial, and 287 irrigation. HREC serves 2,631 customers: 2,226 residential, 187 commercial/industrial, and 218 irrigation.

Hood River County lies in a climatic transition zone between the marine influence of western Oregon and the semi-arid climate of eastern Oregon. It is characterized by four distinct seasons and an annual rainfall of 28.47 inches. Average January temperatures are 33.1 ^{o}F; July 67.5 ^{o}F.

Hood River County is typical of the region in its scattered, largely rural population with small but easily identified community concentrations. It mirrors, in its cultural and political attitudes, the character of the region's people. The economy reflects a cross section of industry and employment typical of the Pacific Northwest. Its geographic location with both marine and arid climate influence, distinct seasons, and temperature diversity provides clear reference points to other sections of the region.

The historical and social basis of Hood River reflects that of the region. The first non-native settlers were principally of English, Finnish, German, and Japanese descent. The first land claim was recorded in the vicinity of the present city of Hood River in 1854. Hood River County was established on June 23, 1908, with the town of Hood River selected as the seat of the county administration.

The major sources of revenue in the study area are agriculture, timber, lumber, and recreation. Agricultural potential has been increasing as compared to other primary industry, lumber, and lumber products. The Hood River Valley produces fruit of exceptional quality and is recognized as a world leader in pear production. The fruit production area is approximately 10

miles wide, extending southward 25 miles from the Columbia River to the slopes of Mt. Hood.

The lumber industry has been experiencing a period of adjustment with several small mills closing. While logging and sawmilling have long been a substantial part of the Hood River economy, the trend is toward fewer but larger mills.

Outdoor recreation is an important economic supplement. The study area's proximity to the metropolitan Portland area provides a regular source of revenue and cultural interaction. Popular activities include boating, camping, hunting, fishing, hiking, and skiing.

Comparison Communities

Two study areas were selected as comparison communities for the Hood River Program. The selection criteria are based on consideration of population, location, economy, and climate. For purposes of evaluation, it was essential to maintain rate experience in the comparison communities identical to that of Hood River. For this reason the State of Oregon was examined first. Each of the 28 counties in Pacific's Oregon electric service area were considered. Sites which did not meet the established criteria were eliminated. As a consequence of this process, two comparison areas were selected: (1) Grants Pass, Oregon and surrounding Pacific service areas in Josephine County, and (2) Pendleton, Oregon and surrounding Pacific service areas in Umatilla County. A discussion of selection criteria is presented below.

Population

A. The area is semi-rural with at least one community over 200 and none over 25,000.
B. The population within the county and within Pacific's service territory is large enough to sample.
C. Customer population characteristics are "like" Hood River based on per customer annual kiloWatt-hours and electric end-use proportions.

Grants Pass, with a population of 15,050 (1980), is the largest city within Josephine County; Pendleton, with a population of 14,656 (1980), is

the largest city in Umatilla County. Pacific Power serves 23,000 residential customers in Josephine County and 16,000 residential customers in Umatilla County.

Location

A. No physical proximity to either Hood River or Portland.
B. Limited or no reliance within the comparison community on Hood River or Portland news media.
   Presence of a local news source.
C. Absence of significant recent or ongoing community conservation programs near or within the community.

These criteria both avoid reaction to the Project and maintain relatively pure comparisons representative of the Northwest experience. Both communities selected are physically isolated from the Hood River Program and other active community conservation campaigns conducted by the Bonneville Power Administration or Pacific Power. Grants Pass and Pendleton are major community concentrations within their counties, each having a principal local news source. The East Oregonian newspaper is published each weekday and Saturday in Pendleton, as is the Daily Courier in Grants Pass.

Economy

Each area has a diversified economy influenced by general economic conditions neither significantly more nor significantly less than other areas of the region.

The economics of Josephine and Umatilla counties are diversified and relatively stable. The major industries are lumbering, tourism, and agriculture in Josephine county; and agriculture, lumbering, food processing, and manufacturing in Umatilla County. Percent dependence of total manufacturing income on lumber and/or paper products is 68.5 for Josephine County, and less than 60 for both Umatilla and Hood River counties. Unemployment rates from the State of Oregon Employment Division, August 1982 are 13.0 percent for Josephine County, 10.5 percent for Umatilla County, and 16.4 percent for Hood River County. The state of Oregon seasonally adjusted unemployment rate for this data is 10.8 percent.

Climate

The communities selected represent two distinct climates found within the region. Both are referenced in the climatic transition zone in which Hood River is located. Josephine County, located in southwestern Oregon, has a temperate climate with mild, wet winters and hot, dry summers. The average annual rainfall is 28 inches, average January temperature 39.3 ^{o}F; average July 71.2 ^{o}F. Umatilla County, situated in northeastern Oregon, has a temperate, semi-arid climate with an average annual rainfall of 12 inches; average January temperature of 32 ^{o}F; average July temperature of 73.5 ^{o}F.