IMPACTS AND OPPORTUNITIES FOR AQUATIC BIOTA ASSOCIATED WITH ENERGY DEVELOPMENT IN NEVADA

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ABSTRACT: The impacts and opportunities for aquatic biota associated with energy developments in Nevada have been limited to this point in time but as environmental concerns of neighboring states such as California increase as well as more land areas for energy development become limited, Nevada will receive more pressure for energy developments. Projected electrical energy sales in the State of Nevada are from 7,623,731 MWH in 1975 to 18,518,390 MWH in the year 2000.

If proper planning goes into energy developments in Nevada there are possible opportunities for aquatic biota such as: 1. utilization of waste heat sources to produce aquatic food organisms; 2. development and maintenance of aquaculture systems; and 3. creation of additional waterfowl habitats in arid climates.

INTRODUCTION

Energy development in the state of Nevada has been fairly low key until the early 1970's when the rapid expansion of the population began. Along with the population expansion, came the oil embargo which caused a great deal of concern for the growth of the tourist related industry so prevalent in Nevada. Up to this point in time, the energy developments have been primarily fossil fuel electrical production with the exception of the Hooover and Davis Dam hydroelectric developments on the Colorado River.

Electric power used in Nevada is supplied by 22 utilities located throughout the state including 15 certified electric utilities and seven municipalities. However, Sierra Pacific Power Company, which supplies much of northwestern Nevada, and the Nevada Power Company supplying the Las Vegas area and portions of northeastern Nevada, service 95 percent of the population of the state.

Sources of electrical energy used in the state include:

1) Steam electric generating plants.

2) Hoover and Davis dam hydroelectric

3) Various gas turbine, diesel and hydroelectric facilities (small scale)

4) Out-of-state purchases

The major steam electric generating plants include:

A) Four owned fully or partially by the Nevada Power Company

1) Clark Station 252 mw

2) Sunrise Station 152 mw

3) Reid Gardner Station 330 mw

4) Mohave Station 1636 mw
(14% of which is owned by Nevada Power Company)

B) Sierra Pacific Power Company (two plants)

1) Tracy Station 246 mw

2) Fort Churchill Sta. 220 mw

The total amount of electric power generated in Nevada in 1975 was nearly 14 million megawatt hours. Total sales of electric power to end users in Nevada was slightly over 7.6 million megawatt hours. Total electrical flows out of Nevada for the same year were slightly over 7.3 million megawatt hours. However, with the rapid growth taking place in Nevada both north and south the outward flows will not be for very long. According to D.O.E. (1977) projections, the electrical energy need of Nevada will go from the 1975 level of 7.6 million megawatt hours to 10.3 million megawatt hours next year (1980), 14.8 million in 1990 and 18.5 million in the year 2000. That means one of two things must happen:

1) Nevada utilities will have to purchase more out-of-state power or

2) Nevada will have to develop new sources of energy within the state.

The first is not too likely in that adjoining states are also experiencing increased energy demands.

IMPACTS OF EXISTING ENERGY PRODUCTION ON AQUATIC BIOTA

A good case in point of what the impacts of energy production of energy production on aquatic biota have been, and the environmental adjustments that have been made, might be to pick on a single power station as an example. The station I will use as an example is the Tracy Power Station on the Truckee River. The first unit of Tracy went on-line in 1963 ahead of the national outcry of environmental concerns. The first unit drew its cooling water supply directly from the Truckee River with only trash racks over the intake line and discharged 100 F water directly into the river. It was a once-through system which was the simplest system to build from a power production viewpoint and the eco-nuts, as they are now called, were not around.

The second unit at Tracy was put on-line in 1965 when the environmental movement first started coming to life and concern was raised for the heated discharge to the Truckee River. Sierra Pacific Power Company constructed a 30 acre cooling pond to remove some of the heat before it was discharged. However, the water discharged was still often 8-12 F above the Truckee River water. The water intake system was the same as for unit number 1, so the Power Company was improving when it added unit number 2. However, environmental concerns by various agencies were becoming quite vocal. Studies were undertaken on the Truckee River to assess the effects the heated discharges were having on the biotic communities. The exact effects were hard to define because of so many other impacts that had been occurring at the same time such as; the channelization of the lower Truckee River in 1961 by the Corps of Engineers that removed most of the river canopy, deteriorating sewage effluent quality, and rapid growth in the upper Truckee River watershed. With all of the impacts developing in the same time period it was hard to sort out who was to blame for what.

Then in 1973 Tracy Station had unit number 3 come on-line, but this time the Power Company was under fire to eliminate any further degradation to the river biotic communities. As a result; unit number 3 incorporated cooling towers, cooling pond water was recycled to the intake pond and no longer discharged to the Truckee River, and a sophisticated intake gate structure was constructed to prevent the intake of aquatic organisms. With all of these developments associated with unit number 3 and corrective measures for units number 1 and 2, the Power Company was concerned that their heat rate exchange efficiency might cause operating problems. However, as it has turned out, the heat rate exchange efficiency has not changed and the biotic communities are no longer significantly effected by the power plant. The Desert Research Institute, Bioresources Center, has just completed an E.P.A. 316b study on the impacts of the Truckee River intake structure at Tracy Power Plant. We found that the <u>only</u> fish that got into the intake pond were <u>primarily</u> green sunfish that were derived from the cooling pond, which was managed as a warm water fishery. The green sunfish that exist there today are residuals from the management program. This may be one success story where fishery biologists have had an impact, but the many other problems in the Truckee River are far from being solved.

NEW ENERGY DEVELOPMENTS PLANNED FOR NEVADA

As the population in Nevada increases, more energy will be needed. At the present time there are several projects under development or on the drawing board for increasing energy supplies in Nevada. These include:

1) Valmy Station - Sierra Pacific (under construction)

   250 mw Fall 1981

   250 mw 1985

2) Harry-Allen Station - Nevada Power

   200 mw at build out   Coal fired.   9.2 million ton/yr.

3) Warner Valley Station near St. George Utah

   500 mw at build out   Coal fired.   2.2 million ton/yr.

4) Ely Power Station - Question of who will build and operate it - Sierra Pacific Power or White Pine Co.

5) Desert Peak - Geothermal - Sierra Pacific Power and Phillips Petroleum

   20 megawatts by 1980

   20 megawatts by 1983

6) Beowowee - Chevron and Getty Oil. No estimates of size

7) Dixie Valley - Geothermal

The impacts these developments will have is hard to imagine at this point in time. Air quality appears to be the greatest concern in relation to fallout on virgin desert habitats. However, the fossil fuel plants are expected to have minimal impacts on aquatic biota because:

1) They are located in remote desert areas,

2) They get their water supplies from ground water and

3) They do not discharge to any streams, rivers, or lakes.

Geothermal developments offer a great potential for impact on aquatic biota and great possibilities of potential opportunity. Impacts include such problems as:

1) Discharging poor quality warm geothermal water to surface water - H_2S - Salinity

2) Temperature/pathogen problems related to waterfowl areas that could develop

3) Potential toxicity/biomagnification problems related to waterfowl or aquatic/riparian flora and fauna.

4) Disruption of habitat for endemic fish species that have evolved in hot springs - *Crenichthys, Erimichthys, Gila, Rhinichthys*

OPPORTUNITIES FOR AQUATIC BIOTA BY ENERGY DEVELOPMENT IN NEVADA

If proper planning goes into energy developments in Nevada there are possible opportunities for aquatic biota.

For Example:

1) Utilization of waste heat sources to produce aquatic food organisms

2) Utilization of waste stack gases if the good ones can be separated to enhance aquatic plant growth

3) Development of balanced biological systems for food production utilizing both solar and secondary energy now wasted

4) Maintenance of aquaculture systems - catfish, prawns, etc.

A great deal of research needs to be done before any of these developments can become a reality. The Nevada tourist industry supplies a ready market for food sources, but the kinds of food they will utilize and availability of the food product need to be understood.

<u>Geothermal</u>

Much of the geothermal resource in Nevada is low grade in terms of temperature, which limits electric production. However, geothermal resources have the potential for such things as:

1) Aquaculture systems as
   a) heat sources and
   b) growth media
2) Creating waterfowl areas which are, in some cases in Nevada, drying up for lack of water.

The development of these types of programs can help conserve fossil fuel reserves and provide needed societal commodities.

GEOTHERMAL ENERGY AND THE ENVIRONMENT

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ABSTRACT: By the year 2020 the world's presently identified oil reserves will be depleted. The United States has developed a National Energy Plan to conserve remaining oil supplies, reduce dependency on foreign oil supplies, and develop non-conventional energy sources, including geothermal. Geothermal energy could account for 4% of the nation's electrical energy production by 1990. Geothermal resources can be divided into the following types a) vapor dominated, b) liquid dominated, c) geopressure, d) hot dry rock, and e) Magma. Approximately 1.4 million ha of land have been designated by the U.S. Geological Survey as Known Geothermal Resource Areas (KGRA). California and Nevada account for 60% of the KGRA lands. 502 mw of electrical energy is now being produced at the Geysers KGRA. To operate one 110 mw geothermal power plant in The Geysers requires between 16-35 steam wells producing a total of 900,000 kgs of steam per hour for the 30 year life of the plant. The 110 mw power plant and attendant steam wells encompasses about 280 ha of land.

Direct utilization of geothermal energy (nonelectric) is in its infancy in the United States. Geothermal resources with temperature less than 150 C can be used for greenhousing, fruit and vegetable dehydration space heating and aquaculture.

The statement that geothermal energy production is nonpolluting is not entirely correct. Geothermal energy development has inherent restrictions and environmental problems, including site specificity; heat loss during steam/fluid transmission; extensive road, steam and electric transmission line networks; moderate land disturbance, up to 20% of the surface area, and potential air and water quality tradeoffs. Mitigation measures for wildlife habitat losses are generally restricted to revegetation of some denuded areas. In order to better assess the impacts to fish and wildlife resources resulting from geothermal development, baseline data are needed prior to exploration and development activities.

INTRODUCTION

In the very near future the world will be faced with an energy dilemma, especially with respect to crude oil and natural gas supplies. The United States, currently the greatest consumer of oil and natural gas resources, must shift its energy dependency away from oil and natural gas and utilize new sources of energy.

Before man began to exploit the world's crude oil supplies, over two trillion barrels of oil were available for use. Today less than 600 billion barrels are known to remain. You may say to yourself that's a lot of oil and your are right, it is a lot of oil. However, the world uses more than 20 billion barrels a year. In addition, this use is increasing at a rate of about 7% per year (McRae 1977). Therefore, by the year 2020 all presently identified oil reserves will be depleted.

In order to maintain the current oil consumption rate, the world would have to discover another Kuwait or Iran roughly every three years, or another Texas or Alaska every six months (McRae 1977). Finding these new oil resources does not appear promising. Therefore, a plan was developed in the United States to stretch our remaining oil resources, reduce oil dependency and develop new energy resources.

Part of the National Energy Plan goals for 1985 is to 1) reduce the annual growth rate of total energy demands to below 2% (it is now between 4-6%), 2) reduce gasoline consumption by 10%, 3) reduce oil imports to 6 million barrels per day (it is now 16 million barrels per day), and 4) increase coal production by 2/3 to more than 1 billion tons per year. In order to meet these goals, the National Energy Plan directs the nation to expand the use of non-conventional sources of energy which includes solar, solid waste, fusion, and geothermal.

Experts have estimated that geothermal energy could provide about 3-4% of the nation's future energy production, by the year 1990. (Dept. of Energy, 1979). For California geothermal energy could provide as high as 14% of the state's electrical energy needs by the year 1990 (Fredrickson 1977).

Geothermal reservoirs are found throughout the world. However, because of the economics associated with production, only those heat source areas that are relatively shallow usually less than 3 km, are exploited. A geothermal reservoir is usually found in permeable rock in which steam or hot water is stored or trapped. In steam dominated geothermal reservoirs the top of the reservoir is imperfectly sealed by an impermeable cap rock.

There are several different types of geothermal resources that are being developed or explored with respect to energy production. The vapor domiated reservoir (steam producing) provides fewer technological problems. However, these reservoirs are few and far between. The Geysers KGRA in Lake, Sonoma, Mendocino and Napa Counties is composed predominantly of dry steam reservoirs. The liquid dominated reservoir (hot water) is the most common type of all the geothermal resources. The technological problems associated with liquid reservoirs are often times very perplexing. The Imperial Valley, California and most of the KGRA's in Nevada are liquid dominated. Total dissolved solids (TDS) of some liquid reservoirs can reach as high as 250,000 ppm, which pose utilization problems (U.S. Fish and Wildlife Service 1976). Geopressured areas, are primarily located in or near the Gulf of Mexico. Geopressured areas are composed of hot brines (270 C) and methane gas at depth (5-6 km) and high pressure. Hot dry rock is another geothermal energy potential. Hot dry rock is just that there are no liquids or stam associated with this resource. The energy is extracted by drilling two wells in close proximity to each other into a hot rock area. Water is injected at high pressure into one well to fracture the rock between the wells. Water is then pumped down one well, circulated through the fractured rock material and then recovered as hot water or steam by the other well. The use of magma to produce steam is being developed in Hawaii where this resource is close to the surface.

Approximately 1.4 million ha (3-½ million acres) of land have been designated by the U.S. Geological Survey as Known Geothermal Resource Areas in the western United States. California and Nevada account for Areas in the western United States. California and Nevada account for 60% of this area. California and Nevada also account for about half of the 108 listed KGRA's (53). Most of the geothermal exploration and development activities to date have been directed at producing electrical energy. The Geysers KGRA is the world's largest producer of geothermal electric power currently producing 502 mw. By the end of 1980, the Geysers should be producing 600-900 mw of electric power. To put this energy output in proper perspective, an average-sized nuclerar power plant produces 1,000 mw and an average fossil fuel power plant produces approximately 500 mw (Hollander 1976).

Generally speaking, one geothermal power plant in The Geysers producing 110 mw of electric power requires somewhere between 16 and 35 geothermal steam wells for the life of the power plant (30 years). This figure may be different for power plants operating with hot water. In The Geysers one power plant and its supporting steam wells usually encompasses about 280 ha (700 acres) of land. In a liquid dominated area, the land surface required to produce the same 110 mw may be slightly greater depending on the reservoir temperature. To operate a 110 mw geothermal power plant in The Geysers requires approximately 900,000 kgs, (2,000,000 lbs) of steam per hour above 150 C (White 1975). About 80% of the steam is evaporated in the cooling tower, while the remaining 20% is condensed. The condensate is reinjected back into the steam reservoir.

The direct utilization of geothermal energy (nonelectric) is in its infancy in the United States, primarily because the resource is often remote from population centers and because of formerly low cost fossil fuel availability. There are many possible uses for low temperature (below 150 C) geothermal energy. These uses include greenhousing, fruit and vegetable dehydrating, space heating, lumber drying, aquaculture, etc. As the cost for fossil fuels increase, it is very likely that geothermal will be considered as a substitute energy source in the near future.

The exploration for and development of geothermal energy has long been publicized as non-polluting. This is not entrirely true. The development of geothermal energy like all the other energy sources has some inherent restrictions and environmental problems. One of the biggest drawbacks to the utilization of geothermal resource are usually remote with respect to product-use centers. Ofteh times these remote areas have other resource values, such as fish and wildlife, which could be impacted by geothermal energy development.

Another limiting factor is geothermal steam and/or fluids cannot be transported over long distances because of heat loss. To maintain proper temperature and pressure for electric energy production, steam wells at The Geysers are usually located with 1 km (½ mile) of the power plant. Therefore, any development utilizing geothermal energy must be close to the resource site.

Geothermal resource exploration and development activities require an extensive road, steam, and electric transmission line network. Road, pipeline, well pad, power plant, and electric transmission corridor construction accelerates the natural erosion rates in the disturbed areas. Increased sedimentation resulting from erosion can have severe impacts on aquatic resources. The accidental release of geothermal fluids into an aquatic ecosystem can also result in adverse impacts. In The Geysers prior to 1968, geothermal condensate was discharged directly into Big Sulpher Creek (Dept. of Fish and Game 1978). After 1968, geothermal condensate was reinjected back into the reservoir. It is difficult to determine whether or not the pre-1968 discharge had any long-term adverse impacts on steelhead trout populations. However, a New Zealand study (Axtmann 1974) indicated that the direct discharge of geothermal fluids into the Waikato River from the Wairakei power plant contributed to the decline of the trout fishery for a distance of about 13 km (eight miles).

The reinjection of geothermal condensate in The Geysers has not entirely prevented these materials from entering nearby streams. Since 1968 over 35 separate reported condensate spills have occurred (Calif. Dept. of Fish and Game 1978). The immediate direct effects of some spills has resulted in aquatic animal losses, primarily juvenile salmonids. Because of the lack of pre-geothermal development baseline data for steelhead trout in The Geysers, cumulative effects of condensate discharges into the immediate and downstream aquatic ecosystem are subject to varied opinions.

The loss and impairment of wildlife habitat can be a serious problem not only for geothermal development, but for all resource exploitation activities conducted on previously undeveloped areas. To produce electrical energy from geothermal resources requires moderate surface disturbances.

Estimates of land disturbance for geothermal electric power production activities range from a low of about 7% to a high of 20% per power plant and attendant steam supply field. Therefore, if 280 ha (700 acres) are needed per power plant and the attendant steam supply field 20 to 57 ha (49 to 140 acres) of wildlife habitat will be eliminated. Geothermal development at The Geysers has required clearance of approximately 20% of the land area (Suter 1978). Some of the disturbed areas such as cut-and-fill slopes, are revegetated with plant species that provide wildlife benefits.

The degree of land disturbance is directly related to the type of geothermal reservoir being developed, the purpose the extracted energy is being used for, topography, and the method used for treating the spent geothermal fluids. In The Geysers, the amount of surface acreage disturbed by geothermal development has been lessened by drilling multiple steam wells (up to six) on each drill pad.

Geothermal steam and/or fluids contain varying amounts of noncondensible gases and particulates such as carbon dioxide (CO_2), hydrogen sulfide (H_2S), ammonia (NH_3), arsenic (Ar), mercury (Hg) and boron (B). Hydrogen sulfide has received the most attention because its odor is offensive to many people. The average detection concentration for most people is around 3 ppb (parts per billion). In The Geysers, the average emission concentration from a power plant with present H_2S abatement capability is about .5 ppm (parts per million). Boron is belieived to cause plant stressing near the cooling towers in The Geysers (Suter 1978).

There have been four geothermal well blowouts in The Geysers KGRA since the early 1950's. The long-term impact of these blowouts on fish and wildlife resources appears to have been minimal. This is not to say that all geothermal well blowouts will have minimal effects on fish and wildlife. The adverse effects of a well blowout in The Geysers, a steam dominated field, will be different from a well blowout in Mono-Long Valley, California area, which is a fluid dominated field. A well blowout in Mono-Long Valley could release a considerable quantity of geothermal brine onto the surrounding area. Most geothermal brines contain chemical elements that are toxic to wildlife, (ammonia, hydrogen sulfide, mercury, lead, chromium, etc.) which are especially toxic to aquatic species. Therefore, if geothermal brine enters the aquatic ecosystem in Mono-Long Valley, adverse impacts could result, particularly to trout populations.

Various mitigation measures have been proposed to compensate for the adverse impacts associated with geothermal exploration and development activities. As previously noted, hydrogen sulfide abatement has received considerable attention with respect to minimizing cooling tower emission. Industry has proceeded to the point where up to 99.9% of the H_2S in the emissions from future power plants can be abated. Water quality control efforts have been responsible for the reinjection of geothermal fluids back into the ground and thus reducing possible surface contamination. What about adverse impacts to wildlife habitat? Progress in this area is slow but steady. The most common wildlife mitigation measure implemented by geothermal developers, with respect to all of the various techniques recommended, is revegetation for erosion control and wildlife benefits. Surface areas denuded of vegetation, which are not required for normal geothermal operations have been seeded and/or replanted with grasses, legumes, shrubs, and in some instances trees. Efforts are made to use plant species which are beneficial to wildlife. Follow-up evaluations in The Geysers of the seeding/replanting efforts are not normally made. Therefore, the success of the program with respect to erosion control and wildlife benefits is unknown. In time the native plant community will reestablish itself on the disturbed areas.

It is difficult at the present to make value judgements regarding the impacts of geothermal exploration and development activities on fish and wildlife resources. The reason for this is baseline fish and wildlife resource data are generally lacking for areas being developed. Without this information project impacts, monitoring results, and mitigation attempts are subject to various and often times divergent opinions. Time and effort should be expended to collect baseline fish and wildlife data on those priority KGRA's before extensive geothermal exploration and development activities begin.

Geothermal resources are a proven energy source. The potential for significant electrical energy contribution to the nation is generally restricted to the far western states; its direct utilization possibilities are potentially very favorable; its impact on the environment--only time will tell.

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