# *How will we resolve this current problem in the Pacific Northwest?*

# NUCLEAR POWER —


By

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Thermal pollution is one environmental problem that man must resolve if he wishes to maintain the quality of his environment. Its magnitude varies throughout the world, as it does within our continental borders.

The status of the problem in the Pacific Northwest is as follows:

**1. At Hanford, Washington, nuclear-powered reactors and an electrical generating plant are discharging waste heat into the middle Columbia River.** The waste heat from these plants and the regulation of flow by hydroelectric plants combine to produce a highly undesirable thermal regime.

**2. A potential further problem has been created by a proposal to install 20 thermonuclear plants by 1990.** Four of these plants, representing a capacity of at least 9,000 MW, have been proposed for installation on the Columbia River. The first two to be announced—the Trojan and Kalama plants—are to be on the lower Columbia River.

In the controversy stimulated by the proposal to produce thermal electric energy of this magnitude, the question was not about the need for this energy but how and where the waste energy (or heat) would be dissipated. Various problems could be created by the discharge of heat into fresh-water systems of the Pacific Northwest.

### Heat only one problem

Increase in heat is not the only problem that fish will be subjected to when thermal plants are installed on their migration routes. Large screening facilities are needed at the intakes of these plants, and the addition of antifouling chemicals further complicate the problem.

In 1966, the largest thermonuclear electric plant in the United States went into production in Eastern Washington, at Hanford. We can compare this plant with future ones by taking a closer look at the statistics for this plant on electrical output, cooling water volume, and temperature increase of the cooling water.

First, the 860 MW of electrical power produced at this plant is less than one-half the installed capacity of Grand Coulee Dam (1,944 MW) and just slightly less than the installed capacity of McNary Dam (980 MW).

**Second, the amount of water pumped daily or diverted from the Columbia River (1,240 cfs) is more than the amount used daily in the entire state of Texas for its domestic water supply. It is over twice the daily domestic consumption in the entire city of Los Angeles. It is more water than the average annual flow of the Wilson River in Oregon or the Washougal River in Washington.**

Third, this quantity of water is increased some 30° F over normal river temperature as it is pumped through the condensers of the plant.

The installation of this plant in eastern Washington was just a small part of a recent movement that is geometrically increasing the growth of the thermal electric power industry throughout the United States. Plans call for the Pacific Northwest to play a prominent role in this expansion in the immediate future.

### To Exceed Hydro Power By 1985

Recently, the Bonneville Power Administration announced a "10-yea[r] plan" of electrical power developmen[t] which included projections of therma[l] electric plants in the Pacific Northwest[.] These projections showed the installa[-]tion of one 1,000-MW plant each yea[r] from 1971 to 1990, or roughly 2[0] plants in 19 years. At this rate of con[-]struction, production of thermal elec[-]tric power will equal or exceed that o[f] hydroelectric power in the Pacifi[c] Northwest by 1985.

Let us review for a moment the siz[e] of these proposed plants as they relat[e] to production output and water use[.] Each of the proposed plants is planne[d] for 1,000-MW capacity; thus each wil[l] be larger than Washington Public Pow[-]er Supply System plant, at Hanfor[d] which a few years ago was the na[-]tion's largest. The water needs for eac[h] of the direct cooling systems will b[e] 1,600 cfs. The water temperature wil[l] be increased 20° F before being dis[-]charged into the environment.

It is well to emphasize here, tha[t] each site selected may have the capa[-]bility of supporting more than on[e] 1,000-MW unit. Selected sites may sup[-]port two, three, or four of these 1,000[-]MW units depending on prerequisites which include geography, ground sta[-]bility, availability to transportation[,] transmission, water supply, and othe[r] engineering requirements.

Consequently, competent engineer[s] are now looking for 20 sites in the Pa[-]cific Northwest that they feel will bes[t] support thermal electric plants. In thei[r] search for sites it is clear that the sin[-]gle most important economic variable i[s] the method used in disposing of wast[e] heat and that direct cooking—with fres[h] water—is the most economical method[.]

The introduction of thermonuclea[r] plants or complexes, of the size pre[-]viously described, presents a number o[f]

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# ANADROMOUS FISH

problems to our fishery resources. These problems are increased in magnitude because our most valuable fishery is basically composed of cold-water or anadromous fish—salmon, steelhead, sturgeon, smelt, and shad. The adult anadromous fish move upstream from the ocean to spawn and the juveniles move downstream to the ocean. It should be understood that one or more of these species, at some stage of development, is found year round in the lower Columbia River.

**Any interference with movement—whether caused by changes in environment (which may be expressed as physical or physiological blocks), lack of proper diet, or the presence of predators, competitors, or disease—would adversely affect important segments of these populations.**

Conflicts of interest between installations of thermal electric plants and our anadromous fisheries exist only where direct cooling is used to dispose of the large quantity of waste heat not used in the production of power.

The problems associated with movement of water through a direct cooling system of a thermal electric plant can be divided into three categories:

1. Problems of water diversion.
2. Protection against condenser fouling.
3. Water temperature increases.

Let me review the fishery problems caused by the direct cooling systems of thermal power plants by category, and theoretically apply them to the Kalama site—with the assumption that direct cooling will be incorporated into design features at this location. Let us further assume that this plant is designed for 1,600 cfs initially and 3,200 cfs on final installation. The temperature of the water diverted from the Columbia River would be increased about 20° F.

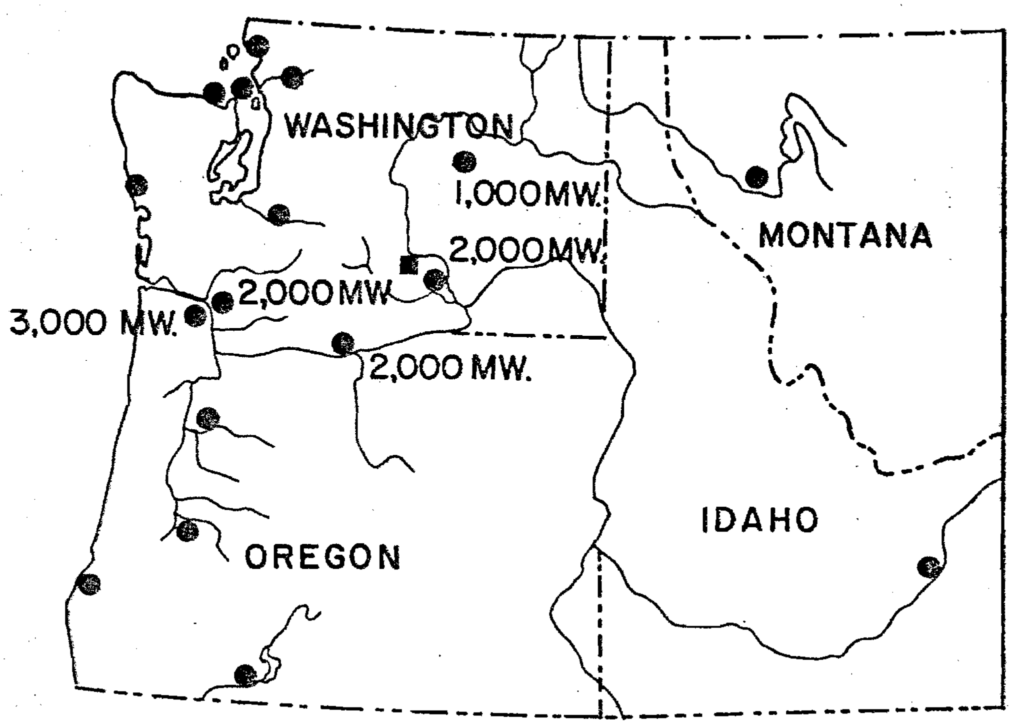
**Complications Set In**

In the first category, water diversion, plans must be formulated to screen from 1,600 to 3,200 cfs. The technology is available to provide adequate screening for any facility, but as the size of screen mesh decreases, the cost of screening increases. Small-mesh screens will be necessary at the Kalama site because it is near or adjacent to spawning areas of shad, smelt, and sturgeon. The fry of shad, smelt, and sturgeon and the floating eggs of shad that could pass through the screening systems would be subjected to sharp fluctuations in turbulence, pressure, velocity, and temperature.

In the second category, the use of chemicals to prevent fouling of condensers or intake screens, could be a serious threat to aquatic organisms. Chlorine, sodium hypochloride, and other chemicals are used to control algae, bacterial or fungal slime, or any other organisms which decrease the efficiency of the screens and cooling systems. Because these antifouling materials are specifically designed to inhibit or eliminate growth, they are potentially lethal to some aquatic organisms.

It can be predicted that the slime fungus **Sphaerotilis,** which is abundant in the lower Columbia River, may cause a serious fouling problem on the intake screens of the Kalama plant. It is im-

THERMAL-ELECTRIC PLANTS IN PACIFIC NORTHWES



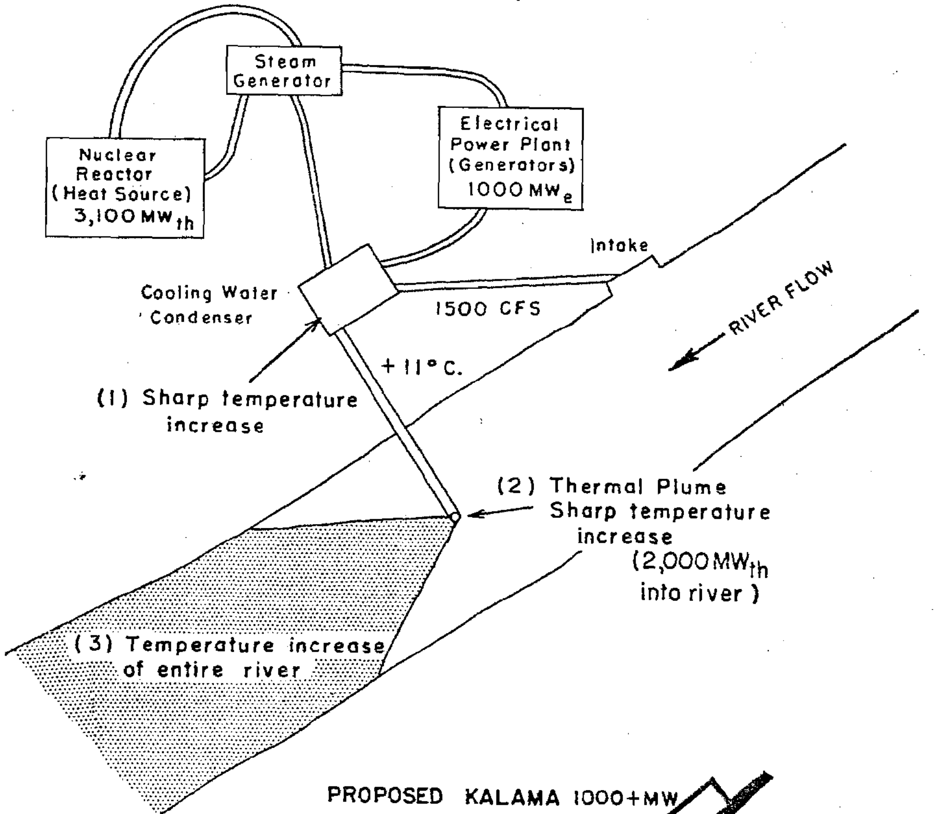

● Planned ■ Existing

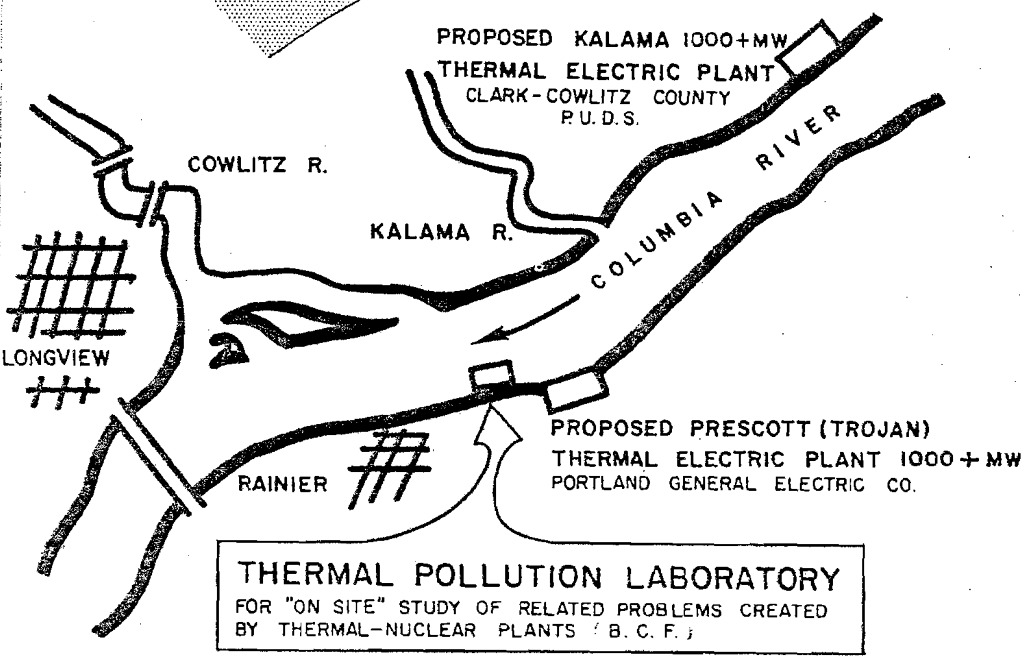
portant that fishery agencies know the type, concentration, and frequency of application of antifouling materials so that the chemical effect on aquatic organisms can be forceseen. Minor scaling of the condenser tubes will be a potential problem at Kalama. The problem can be resolved through addition of acid to neutralize alkalinity, but the acid solution used for this purpose could be detrimental to some juvenile fish.

The third category of fishery problems—and probably the one most frequently discussed—is the discharge of huge quantities of heated water into the river. Thermal electric plants are inefficient energy-conversion systems; over two-thirds of the total heat energy produced by the reactors is discharged into the environment and only one-third is used in the production of electricity. Unfortunately, the recent technological advances in the thermal nuclear power industry relate to the production of larger volumes of heat; less effort has been expended to increase efficiency (ratio of heat energy produced to heat energy converted to electricity). The impact of this waste on the aquatic flora and fauna is felt in three specific areas:

1. At condensers, where the temperature increases sharply.
2. Near the thermal plants, when waste water is discharged at points where temperatures of the plume (a colorful name applied to the heated water streaming from its point of discharge until it is diffused in the environment), and the surrounding river water differ greatly.
3. Within the entire receiving body of water, after complete diffusion of the plume.

**Figure 2.—Three areas near, or in, thermal plants where temperature increases will affect aquatic biota.**




The sharp temperature increases in the condenser tubes can affect only the organisms that pass through the intake screens. The eggs and young of some of our anadromous species are of such a size that they would pass through screens of normal size to the condenser and be subjected to this 20° F "thermal shock." Zooplankton—which comprises the many tiny aquatic organisms used for food by some fish—will certainly be subjected to this sharp heat increase. We do not have adequate information at this time on what effect this amount of instantaneous temperature increase will have on most aquatic organisms in the Columbia River, but we should not allow direct cooling systems to operate in this area until these facts are known.

The sharp temperature increases in the thermal plumes can potentially affect fish moving up or down the river. At the present time we know relatively little about the physical dimensions of these plumes. We do know, however, that the discharge structures at nuclear plants would be large (11 feet in diameter) and probably on the river bottom. We suspect that this hot water would erupt at the surface and exhibit only limited horizontal expansion until diffused downstream.

### Fish Die In 4-11 Seconds

Fish may not be able to avoid the thermal plumes as they migrate to the ocean. Young fish tested at the BCF (Bureau of Commercial Fisheries) water temperature laboratory at Prescott, Oregon, apparently did not detect rapid temperature changes at 30° F (thermal shocks) for several seconds, but these same fish died 4 to 11 seconds later. Although these experiments were conducted in the laboratory, we wonder if a 3-inch fish could escape from an 11-foot diameter plume in time to prevent death. We suspect that juvenile salmon may not be killed directly by a 20° F temperature increase in the thermal plume at low river temperatures, but a rapid 20° F increase when the river temperature is approaching 70° F will prove fatal. Experiments of this type are continuing at the Prescott Laboratory.

The subtle increases in total river temperatures may not be so subtle when compounded by low flow and tidal fluctuation. Many of you have been exposed to the predictions of total river temperatures that can be expected from a standard 1000-MW thermal electric plant. These predictions have been based on a total and continuous downstream flow of at least 100,000 cfs. The problem will be compounded by Canadian storage, when the flow in the lower Columbia River will be drastically reduced and will fluctuate in volume daily.

A thermal electric plant producing 1,000 MW of electricity, at the present efficiency rating, will raise the temperature of the river flowing at 100,000 cfs only 0.3° F. At 60,000 cfs, however (after storage in Canada and above the Cowlitz River), the increase will be 0.5° F. If the 2,000-MW plant is completed, the increase will be about 1.0° F.

Problems could occur during flow reversals (upstream flows past thermal plants), caused by tidal action. This situation could theoretically triple the predicted increase in temperatures because river water would flow downstream past the discharged heat, stop and return upstream, and then stop again before flowing downstream. This sequence of flows would encourage accumulations of temperature in a specific water mass. (Thus a 2,000-MW plant discharging heated water into a flow of 60,000 cfs at maximum flow reversal could increase the temperature of the entire river about 3° F; hot spots would range up to 20° F above surrounding river temperatures.)

This water mass, which has accumulated in the flow reversal process, may as it moves downstream: (1) block or delay upstream migrations of adult fish, (2) force young downstream migrants to move prematurely out of a physiologically necessary transition zone into salt water, (3) change the species composition of the food organisms of the feeding fish, (4) encourage predation and competition by undesirable species, and (5) encourage parasites and diseases.

Although I have only touched the surface of the major problems associated with thermonuclear plants and the fisheries of the Columbia River, it is important to note here that almost all of the major problems can be resolved simply through the use of off-river cooling systems.

**PGE To Use Off-river Cooling**

Recently the Portland General Electric Company announced its intentions to provide off-river cooling facilities at the proposed Trojan Thermal Electric Plant at Prescott, Oregon. Cooling towers will be constructed to help protect the fishery resources of the Columbia River from the threat of thermal pollution.

Water-use agencies should not be lulled into complacency, however, by the action taken at this one location. This announcement of off-river cooling may or may not set a precedent for future plants. I think that at least three important avenues of action need to be taken by individuals and agencies to resolve these problems successfully: (1) We must establish flow regulations for the Columbia River; (2) we must establish strong legislation that will provide for a compulsory review of each proposed thermal electric site . . . ; and (3) we must conduct further research to define the effects of nuclear plants on our anadromous fisheries.

We must establish water flow regulations for the Columbia River because the dillution effect of the main river on any type of pollutant discharge can be maintained only through realistic flow standards. We are presently using Model T regulations for a river development program in the atomic age. Twelve dams have been constructed on the mainstem Columbia River, negotiations with Canada have been completed to provide for the storage of 25 million acre feet of water. We have made provisions to help prevent flooding of the lower river but have not included provisions to maintain adequate river flow.

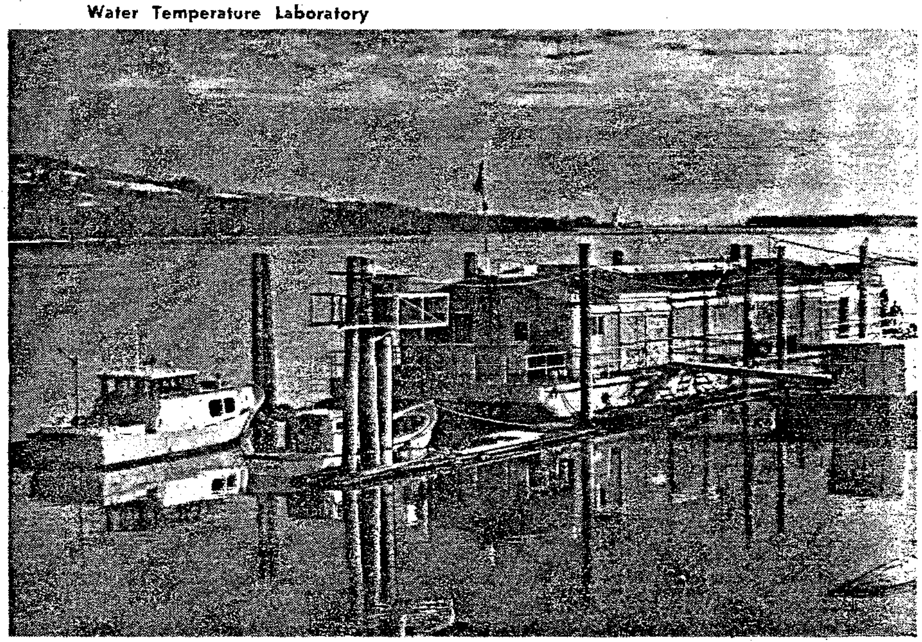
What will happen during 1 or 2 consecutive years of low precipitation and run-off in the Columbia River Basin after the Canadian storage program is completed? We store water during the peak of the run-off. We thus reduce the natural flow of the river during a time when solar heating of the river is at its maximum. Simultaneously, because the reduced flow is producing less hydro power, we use more thermal power and increase the amount of heat discharged to the river.

Only two regulations now prevent the river flows from being reduced below 40,000 cfs in the lower Columbia River: (1) an FPC (Federal Power Commission) ruling of 35,000 cfs in the license for Priest Rapids Dam and (2) a Corps of Engineers ruling for navigation below Bonneville Dam of 40,000 cfs, established at a hearing in the late 1930's or early 1940's.

If the incorporation of direct cooling is allowed at the Kalama plant, the completed facilities would use almost 10,000 cfs or one-fifth to one-sixth of the low-flow minimums for this area. We need to have low flow requirements established at a reasonable level for the lower Columbia River to protect the interests of all water users.

The second step in solving the problems of thermal pollution—the establishment of strong legislation that will provide for a compulsory review of each proposed thermal electric site by qualified pollution control and fishery agencies to identify and recommend solutions to specific problems—is mandatory. Such a review is not now required. Permission is given to construct and operate thermal nuclear electric plants by the AEC (Atomic Energy Commission), which carefully evaluates the environmental impact of a plant on public health as it relates to the potential danger from the atomic reactor, the proximity to large population centers, and the release of radionuclides into the water. Permits can be issued by AEC without considering other changes that can result from such an installation, such as the amount of water to be diverted, the total temperature impact on the aquatic environment and its organisms, the chemical

**Water Temperature Laboratory**



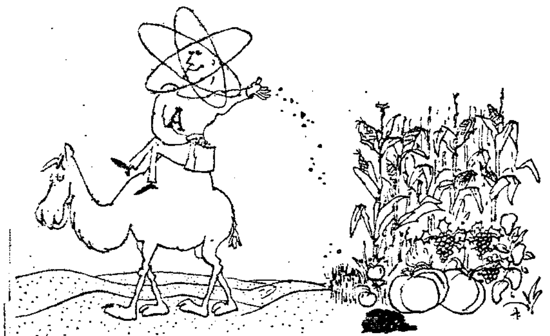
treatment, and the mesh size of screens used.

In contrast to this lack of protective legislation for thermal electric sites, fish and wildlife agencies in an area review for the FPC the resources affected by a hydroelectric dam. The FPC will not approve construction of a facility until the agencies have reviewed the proposed fish facilities and are satisfied with the proposed structures. The agencies can recommend changes to the structures before the dam can be installed.

It is a popular assumption that because hydroelectric dams in the Northwest receive thorough preinstallation scrutiny, thermal electric plants receive the same treatment. Such is not the case.

**FPC Lacks Review Authority**

It amazed me to learn that the FPC does not have the authority to review proposed thermal electric plants (either fossil fuel or nuclear) unless the plant is associated with, or an integral part of, a hydroelectric facility. This lack of authority exists even when over 80% of the total electric power produced in the United States originates from thermal electric plants.



It is because of a compulsory review of hydroelectric plants by fishery agencies that the Columbia River still has an anadromous fishery. For example, fish ladders at main stem Columbia River Dams, which cost 15 to 25 million dollars, were installed as a result of such a review. These structures serve to pass the upstream migrations of anadromous fish; thus, they solve a part, though only a part, of the problems created by a hydroelectric dam. In contrast, when thermal plant construction is involved, utilities seem reluctant to commit 5 to 7 million dollars and the highly developed technology of cooling towers, which will resolve most of the fishery problems related to the anadromous fisheries.

The third step toward the solution of the thermal pollution problem lies in the area of research. We need more information to define clearly the detrimental effects of nuclear plants on our anadromous fisheries. The Federal Water Pollution Control Administration, AEC, and BCF have entered into a three-way research partnership to define more clearly the effects of present and future thermal increases on the anadromous fishery of the Columbia River.

Two types of research are needed to supply realistic solutions to the problems created by thermal plants:

1. **General research:** types of fish that will be affected; life history stages that will be subjected to the triple threat of water diversion, chemicals, and thermal pollution; and tolerance levels of these fish to increased heat and added chemicals.
2. **Site-specific research:** determination of the periods when the fish are in the river; their distribution at the site; temperature and chemical composition of the water; characteristics of river flow; and favorable and unfavorable characteristics of the proposed installation that will affect fish at a specific site.

Further, we need to initiate studies that will point out how we can make beneficial use of waste heat. It is inconceivable for me to believe that one of the largest industries in the United States today, the electric power industry, has progressed to this stage in technology and is still wasting large quantities of heat into the environment. Some ray of hope exists in the future—it has been predicted that thermal efficiency will increase from the present 32% to 42% by 1985—yet over half of the heat generated in an atomic reactor will need to be disposed of.

Scientists in our laboratory realize the tremendous potential in the use of this heat to increase fish and shellfish production in our coastal waters **under controlled conditions.** For example, some of our salt water is occasionally too cold for reliable spawning of shellfish. (A large portion of our oyster seed is imported from Japan.) The BCF's Seattle Biological Laboratory is investigating the beneficial aspects of heat proposed for discharge in the Puget Sound area. Several proposals have been made to test the beneficial effect of heated water. Agricultural use is also contemplated, as in the land ownership irrigation system, proposed by the Eugene Water and Electric Board, Weyerhaeuser Co., Vitro Corporation of America, and farsighted farm owners.

**The placement of thermonuclear plants on a river system—without cooling towers—may produce disastrous results. The Columbia River, and many of our other larger rivers, even now are considered only marginal for the production of anadromous fisheries. The addition of thermal electric plants could significantly favor less desirable species.**

We have passed through the era of the hydroelectric boom and with luck and some careful planning we have been able at least to maintain our valuable anadromous fisheries. As we enter into this new thermal electric era, we should insist that each thermonuclear plant be designed and operated to eliminate harmful effects on our fisheries. ■

## NUCLEAR POWER

Nuclear power—that is, electric power generated by nuclear energy—may be expected to transform human existence within a comparatively short time.

To begin with, in our modern industrial society living standards are directly correlated to the amount of energy used per person. As energy use goes up, living standards go up. In the United States, the use of electric energy is growing at about 2.5 times the rate of total energy use. Thus, the implications of expanding nuclear power are limitless. It is estimated that electric power companies with present construction schedules will have in operation over 17-million kilowatts of nuclear capacity in 1971 and over 27-million kilowatts in 1972. Two factors—reliability and safety of operation—have governed the development of nuclear power by investor-owned electric companies. These are overriding considerations to an electric utility company.

As far as the public is concerned, nuclear power opens the way to solution of what would be otherwise insoluble resource and population problems. One pound of uranium can liberate the equivalent energy produced in the combustion of 2,400 tons of coal; and since there is no combustion in the atomic fission process, nuclear power plants assist in the electric power industry's continuing efforts to reduce air pollution.

Thanks to nuclear power, "There is every reason to believe the United States will continue to enjoy the abundance of low-cost electric power that has helped make it the most electrified and most industrialized nation with the highest standard of living on earth."