# UNESCO Meeting On Ecology And Control Of Aquatic Vegetation, December 16-18, 1968, Paris

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## INTRODUCTION

UNESCO is one of the 14 non-political international organizations within the framework of United Nations. Those with which I am familiar are the Food and Agriculture Organization (FAO) with headquarters at Rome; the World Health Organization with headquarters at Geneva, Switzerland; and the Educational, Scientific, and Cultural Organization (ESCO) with headquarters at Paris.

UNESCO has numerous programs (Table 1). The two best known to me are the International Hydrological Decade (IHD), which is concerned with the world's water resources, and the International Biological Program (IBP), which is concerned with the long-term biological effects of man's activities on biotic balances of fauna and flora and upon man himself. These are both scientific functions. There are many other programs on educational and cultural functions.

As in most international organizations, the wheels in UNESCO move slowly. The Coordinating Council of the IHD, at a meeting in January 1967, decided that excessive aquatic vegetation is a serious and rapidly increasing threat to the conservation and utilization of fresh waters and coastal water resources in most of the 125-member countries. The Council directed that a meeting of world specialists in aquatic vegetation be convened to study the problem and recommend solutions for the guidance of member countries. After several months, Dr. Julian Rzoska, Scientific Coordinator, Productivity of Freshwater Communities (PF), of the IBP in London, was authorized to survey the talents of aquatic weed specialists in various countries, and to recommend names of those who should be invited to attend a working meeting scheduled for December 16-18, 1968. Questionnaires were sent out February 29, 1968, to a number of aquatic plant scientists throughout the world, including several in the U.S.A.

TABLE 1.—United Nations Non-political International Organizations

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| (UN)ESCO—Educational, Scientific and Cultural Organization—Paris |
| IBP—International Biological Program |
| PF—Productivity of Freshwater Communities |
| Six other sections |
| IHD—International Hydrological Decade |
| FAO—Food and Agriculture Organization—Rome |
| WHO—World Health Organization—Geneva, Switzerland |
| Eleven organizations |

I returned my questionnaire promptly but heard nothing more about the meeting until September 28 when I was notified that I had been selected from the U.S.A. to attend the meeting and that my contribution to the source material was due in Paris by October 15. Despite the short notice I submitted a preliminary draft by October 21 and the final draft on November 15. By December 10 I had received 290 pages of source material from UNESCO, submitted by other scientists, and was asked to review and analyze the material by the time the meeting would begin December 16.

I left Laramie, Wyoming, at 10 a.m. on December 14 with a briefcase full of unfinished work, and arrived at the Paris Le Bourget airport at 8 a.m. on the 15th, 1 a.m. Laramie time. Despite only 3 hours sleep on the plane and because I would have only 3 more days in Paris (all working days), I decided to spend the remainder of that day, Sunday, getting a glimpse of the city.

## REPORT OF MEETING

Our first session of the conference on aquatic vegetation was at 10 a.m. Monday, December 16, in the beautiful 7-story, Y-shaped UNESCO building at Place de Fontenoy, only two blocks from my hotel. Although the building must be nearly 20 years old, it appears to be, and probably is, one of the newest public buildings in Paris. The grounds are beautifully landscaped and there is a forest of 125 flagpoles, one for each member nation. I was told that they formerly flew all of the flags every day but now do so only on special occasions. You can imagine the amount of manpower and expense required to raise and lower 125 flags every day.

Our meeting room was on the mezzanine of the attached 3-floor conference building, and it was exactly the right size for the 18 delegates. My place at the circular counter-like conference table, similar to that used by the Security Council of the UN at New York, faced a wall that was one huge many-paned window which provided a view of an attractive segment of Paris. The 18 specialists around the table were from at least 12 different nations of five continents: one each from North America, South America, Africa, and Asia, and the remainder from Europe. There were two each from Britain, Holland, France, and Czechoslovakia, and one each from Beligum, Switzerland, Poland, Portugal, India, Rhodesia, Trinidad, and the U.S.A. I didn't learn the nationality of two members of the UNESCO Secretariat at Paris. Two of the scientists were women, one from France and the other from Czechoslovakia.

The meeting was opened by Jose da Costa, Chief of Hydrology for UNESCO, a native of Portugal. After brief remarks on the reasons for and objectives of the meeting, he designated Dr. Julian Rzoska of the IBP, a native of Poland, as temporary chairman of the meeting. Dr. Rzoska announced that our first half day from 10 a.m. to 1 p.m. would be utilized for brief summaries of not to exceed 10 minutes for each of the 35 resource papers that had been submitted.

All of the discussions were in English with occasional translations of certain portions by Dr. Rzoska for the Czech and French delegates. Papers had been submitted by several specialists in Australia, New Zealand, India, and France who were not present. Those papers were reviewed briefly by Dr. Rzoska. By 1 p.m. we had covered the most significant points in more than 300 pages of source material. We then recessed for 1½ hours for lunch and coffee. I especially enjoyed the leisurely after-lunch visits over coffee. The afternoon sessions were from 2:30 to 6 or 7 p.m.

In our second session after lunch on December 16, we unanimously elected Dr. Rzoska, a silver-haired gentleman of long experience and sound judgment, as permanent chairman. We decided to utilize the next 2 days, acting as a Committee of the whole, in developing a report to the Coordinating Council of the IHD. The report was to summarize the combined judgments of the specialists on all aspects of the ecology and control of aquatic vegetation.

The official report of the meeting at Paris, available for only limited distribution, comprises 15½ pages. That is considerable condensation of the more than 300 pages of the source material with which we started. Obviously, I will have time today to present only a much more condensed version of that condensed report.

We first prepared an analysis of the role of aquatic vegetation with regard to desirable economic and recreational uses, especially in lakes, ponds, and marshes. We then summarized the undesirable effects of excessive aquatic vegetation on movement of water in canals, on navigation of boats, rafts, and ships in channels and streams, and on utilization of water resources in lakes, ponds, streams, and other bodies of water for fishing and recreation (Table 2). These analyses or summaries were arrived at by compromise, because of the diversity of scientific disciplines and viewpoints represented. Fortunately, we had an excellent balance of agronomists, biologists, botanists, ecologists, biochemists, entomologists, hydrologists, and a taxonomist. I believe those compromises were reached more quickly and soundly at Paris than if they had been undertaken by a similarly varied group of American scientists at such universities as Cornell, Wisconsin, or California at Berkeley.

TABLE 2.—Analysis of Aquatic Vegetation in Relation to the Needs and Uses by Man.

A. *Beneficial role of plants in aquatic ecosystems*
1. They provide shelter and a variety of habitats for fish and other organisms.
2. They provide food for fish and other organisms, including intercepted detritus.
3. They consolidate the beds and banks of channels.
4. They improve chemical conditions, particularly by their photosynthetic oxygen production.
5. They assist in the recovery of polluted waters and the maintenance of clean water.

B. *Undesirable effects of aquatic vegetation*
1. They obstruct flow of water.
2. They obstruct navigation.
3. They obstruct water intakes.
4. They interfere with recreation pursuits.
5. They interfere with fishing, fish production, and other crops of aquatic environments, and irrigated lands.
6. They increase loss of water through evapotranspiration and seepage.
7. They interfere with maintenance of wildlife habitats.
8. They create conditions favorable for pests, diseases, and vectors affecting humans, animals, and plants.

Even the most conservative ecologists at Paris could not help but be impressed by the disastrous consequences of excessive aquatic vegetation, especially in underdeveloped countries such as Congo, Sudan, India, Pakistan, and certain other African, Asian, and Latin American nations. In such countries where railroads, highways, and other means of transportation are very limited, the rivers, streams, and lakes are the chief avenues for transportation of people and produce and important sources of fish and other animal and plant food. When aquatic vegetation prevents such uses of water resources, it is a national calamity.

Despite recognition of the critical problems created by aquatic vegetation, especially in developing countries, the meeting then formulated a conservative but sound policy statement which will appear in the final approved report.

All of the scientists were objective and cooperative when various methods of controlling aquatic vegetation were discussed and the advantages of each were listed. Because chemical control is the most widely used method in Europe and North America, it was considered first. The report on chemical control was as follows:

## Chemical Control

The meeting noted extensive research is underway in many countries to discover and develop more effective and selective, but also less toxic and expensive herbicides, and agreed upon a number of conclusions. These efforts deserve the strongest support. When used properly, herbicides can be efficient and versatile tools for aquatic weed control. The present herbicides are at present most widely used (but their application may produce undesirable aesthetic effects): (2,4-dichlorophenoxy) acetic acid (2,4-D) and other phenoxy herbicides, 2,2-dichloropropionic acid (dalapon), 6,7-dihydrodipyrido[1, 2-*a*:2′,1′-*c*] pyrazinediium salts (diquat), 1,1′-dimethyl-4,4′-bipyridinium salts (paraquat), acrolein, xylene, 2,6-dichlorobenzonitrile (dichlobenil), and 3-(3,4-dichlorophenyl)-1, 1-dimethylurea (diuron). Diquat, paraquat, and dalapon are the herbicides most widely used throughout Europe; but diuron is used almost exclusively for control of aquatic and bank weeds in the Netherlands. 3-amino-*s*-triazole (amitrole) and 3-amino-*s*-triazole + ammonium thiocyanate (amitrole-T) are the most widely used herbicides for aquatic and bank weeds in Australia. They were omitted from the list largely because of restrictions in the U.S.A. The following advantages and disadvantages of chemical control were discussed and approved:

A. *Advantages*
1. Applications are usually easy and rapid for canals and large areas in ponds, lakes, and streams.
2. Plants die in situ, usually without obstructing installations.
3. Herbicides provide a wide range in rapidity of action (e.g., acrolein vs. 2,4-D or diuron).
4. They provide a wide range in persistence of activity (e.g., diquat vs. dichlobenil).
5. They are often less expensive than mechanical methods where labor is scarce and expensive (e.g., 2,4-D).
6. Some herbicides are safe for fish (e.g., diquat, paraquat, dalapon).

7. Some herbicides are safe for humans and livestock (e.g., dalapon, diuron).
8. Some herbicides can be applied by individual persons (e.g., dalapon).
9. Some herbicides selectively remove undesirable plants from aquatic complexes (e.g., *Myriophyllums* from *Potamogetons*).

B. *Disadvantages*

1. Most herbicides except 2, 4-D have high initial cost.
2. Some herbicides are toxic to fish (e.g., acrolein, xylene).
3. Some herbicides are toxic to humans, and other mammals (e.g., sodium arsenite, 7-oxabicyclo [2.2.1] heptane-2,3-dicarboxylic acid (endothall)).
4. Some herbicides impart undesirable tastes and odors (e.g., phenoxys).
5. Some herbicides in water damage irrigated crops (e.g., endothall, 2-(2,4,5-trichlorophenoxy) propionic acid (silvex)).
6. Some herbicides have a possible long-term effect on ecosystem (e.g., submersed *Myriophyllum* following removal of floating *Eichhornia*).
7. Some herbicides are non-selective and remove all kinds of vegetation (e.g., diquat).
8. A complete kill of submersed vegetation frequently is followed by a massive growth of algae.
9. Most herbicides require repeated applications to maintain control.

These advantages and disadvantages apply to the United States also, except in degree (because of our greater financial resources and scarce and more expensive labor). Herbicides such as dalapon, which can be applied by hand by individual persons, are much more useful in developing countries.

**Biological Control**

Because modern chemical and mechanical control are beyond the economic and technical resources of most developing countries, these nations fervently hope for effective biological agents. The meeting gave full consideration to the possibilities of biological control. It recorded the available and promising biological agents and the sources of information about biological control and listed the advantages and disadvantages of that method.

A. *Advantages*

1. They require lower cost of operation—perpetual control in successful cases.
2. They cause little or no pollution of water.
3. They provide control of vegetation in areas inaccessible to other methods.
4. They provide economic returns if edible fish or snails are used.
5. A considerable yield of fish protein can be expected from herbivorous fishes.

B. *Disadvantages*

1. Many years of research are usually required for discovery, development, and attainment of effective population densities in new environments.
2. Only a limited number of effective organisms has been adequately studied.
3. Host specificity must first be determined by a qualified staff, to prevent possible attacks of biological agent on valuable crops.
4. Certain introduced organisms may displace or eliminate desirable local species (e.g., German carp).

These advantages and disadvantages also apply to the United States. However, our taste for, and use of, snails or the grass carp are of much less economic importance and unlikely to result in extensive use.

**Mechanical and Physical Control**

The use of mechanical and physical control of aquatic weeds is quite primitive in developing countries but has been utilized in several European countries to the maximum extent of its possibilities under their conditions. The list of methods in use and the advantages and disadvantages developed at the meeting are interesting as compared to those in the United States.

A. *Equipment and methods*

1. Cutting or pulling by hand
2. Draining of canals or ponds
3. Raising water level in ponds (flooding)
4. Making aquatic environment for weed growth (e.g., increasing flow, removing silt, shading, preventing eutrophication).
5. Underwater mowing by portable or self-propelled machines
6. Installing booms for diverting floating vegetation from canals and channels
7. Pulling chains, discs, or other tools through canals or channels to dislodge rooted vegetation
8. Removing floating or dislodged submersed or emersed vegetation from water bodies by hand or by machines
9. Burning at the appropriate time

B. *Advantages*

1. They do not pollute water.
2. They cause little or no fish kill.
3. They provide stable conditions for maximum fish production and harvesting.
4. They provide first step in utilization of aquatic vegetation for feed, compost, fertilizer, etc.
5. In excessively eutrophicated waters, part of the nutrient content taken up by plants may be reduced if vegetation is removed.
6. They allow choice between total and partial area treatment.
7. Temporary draining or flooding of a water body may provide an inexpensive control of certain aquatic species.

C. *Disadvantages*

1. They are usually more costly than use of herbicides.
2. In most cases, they are much slower per unit area than chemical control.
3. Operations usually must be repeated frequently to maintain control.
4. Fragmentation may increase the spread and growth of some submersed and less desirable water plants.
5. Dislodged vegetation and fragments clog installations such as grates, screens, and valves of pumping plants and sprinkler heads of irrigation systems.

Much more use is made of hand-cutting, pulling, and removing in Asia, Africa, and even in Europe, than in the United States. Much less use is made of large expensive machinery. Economic resources will probably never permit extensive use of such equipment in developing countries. The advantages and disadvantages of mechanical and physical methods were considered much the same, for other countries, as those usually mentioned for our country.

Utilization of unprocessed aquatic vegetation has been practiced rather extensively in Asian, African, and some European countries (see PL: C.P. 20, the Handbook of Utilisation of Aquatic Plants FAO, 1968). Continuation of such utilization was recommended in our official statement and the variability that can be made of such utilization in different countries was recognized. Aquatic scientists are watching the progress of processing aquatic vegetation in the United States with intense but rather skeptical interest. They realize the limitations of such harvesting and processing procedures under their conditions of agriculture and economic resources. Conclusions of the meeting were as follows:

**Utilization of Controlled Aquatic Vegetation**

1. The meeting was aware of the present limitations of the utilization of water weeds. However, as the cost of removal in certain countries is great, every possible utilization should be explored in order to defray all or part of the costs of removal.
2. Aquatic vegetation may be utilized directly for animal fodder, compost, mulch, and for industrial purposes as recently reviewed in the FAO Handbook of Utilisation of Aquatic Plants.
3. Utilization of water plants will vary in different regions, depending upon manpower, economics, and needs of the local population.

Special consideration was given to the problem of aquatic vegetation in the large man-made bodies of water (reservoirs) that have been, or are being, constructed in many African and Asian countries. The conclusions are summarized in a final recommendation which will appear in the final approved report.

The report of our meeting urged member countries to take full advantage of existing and proposed working groups that are cooperating with the IBP and IHD agencies of UNESCO and of FAO activities and assistance in weed control.

Our last half-day session in Paris from 1:30 to 7 p.m. on December 18 was used for carefully checking the accuracy and clarity of the report, an activity that Dr. Rzoska aptly described as the "cosmetics."

The meeting was one of the most efficiently conducted and productive of the many state, regional, national, and international weed meetings that I have attended in 33 years of research in weed control. The most obvious reason for this was the excellent balance of scientific disciplines represented by the specialists, and the excellent training, and broad or long experience of the participating specialists. Their dedication also helped to make the meeting a success. A major factor was the skillful and tactful but firm manner in which Dr. Julian Rzoska (IBP) conducted the meeting as chairman. He kept the discussions directed toward the major objectives and made skillful assignments to individual specialists for preparation of evaluations or recommendations in their fields of specialization. The specialists carried out their individual assignments with skill and dedication, and they exercised exceptional judgment and understanding in the evaluations of different sections of the final draft of the report. The tact, humor, and firmness of Chairman Rzoska contributed greatly to this final result.