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WILD RICE--SOME NOTES, COMMENTS AND PROBLEMS*

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There are many aspects to wild rice--its history, biology, prospects, management and special problems. Many of these are considered in detail in the papers, articles and reports listed in the attached bibliography. The Minnesota Department of Conservation is charged by law with the protection and management of wild rice growing in public waters and has been since 1939. Under Minnesota laws, wild rice and other aquatic plants growing in public waters have the same legal status as game and fish--being the property of the State in its sovereign capacity insofar as it is capable of being owned. However, in privately-owned areas, such as constructed paddies, wild rice can be grown and managed as a privately-owned crop. Use of surface waters as a water supply for raising wild rice requires a permit from the Minnesota Department of Conservation.

Wild rice has the distinction of being a wild grain which has long been used by primitive peoples but which has not, until very recently, been developed and grown as a crop. It has been harvested as a native self-sown grain and as such is also an excellent fall food for waterfowl. This has caused some conflicts between hunters and harvesters. Some wild rice lakes are also used for the rearing of northern pike for stocking in other lakes. Wild rice is a key feature in multiple-purpose management of many shallow lakes. Such lakes can supply a harvest of the grain, a harvest of fish and raise and provide hunting for wild ducks.

The plant and its requirements

Wild rice (Zizania aquatica) is a robust annual grass that commonly grows in water 6 inches to 3 feet in depth. The seeds or grains which sink and rest on the bottom begin growth by producing a single seed root and a single submerged ribbon-like leaf in late spring. As the plant develops it produces a cluster of several leaves that ultimately float on the water surface. Unbranched roots arise at the stem nodes much like the adventitious roots of corn. In early summer the stem elongates and extends out of the water. The stem has grassy leaves and is terminated by a flowering and fruiting panicle. The female flowers, which produce the grains, are in a spike-like arrangement at the top of the panicle. The male flowers are borne on slender arching branches below the female

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flowers. The height of the mature plant varies greatly but is usually three to four feet above the water surface. The structure of the hollow stem or straw is peculiar in that there are regularly spaced partitions or septa between the stem nodes, thus allowing the stem to float even though portions of it may be injured. The flower structure is also peculiar in that the staminate flowers have six stamens rather than three as is usual in grasses.

The seeds germinate on and the roots grow in lake bottoms in which there is little or no dissolved oxygen. This causes oxygen relationships of this plant to be of special interest.

Growth of the roots of many aquatic plants is dependent upon oxygen received through the tissue from upper parts of the plant. Many such plants have special air-conducting tissues (aerenchyma) in the stems and leaves. That roots of aquatic plants receive oxygen can be demonstrated by observing oxidized iron next to the roots of plants pulled from mucky bottoms. The extent and effectiveness of internal gas transport in wild rice is unknown but may well be a factor that affects the depth to which the plant can grow.

Oxygen relationships of the seed are also of interest. Wild rice usually grows either along streams or along shores of lakes where there is considerable open stretch of water and heavy wave action in spring. These situations bring oxygenated water in contact with the seed. It is known that planting succeeds best in small lakes at places where there is inflowing water and that in large stands there is usually no rice beyond a depth of four feet (probably below the effect of wave action). However, rice often appears in deep water areas if the water level is lowered.

Several years ago we tested experimentally the effects of different dissolved oxygen concentrations on the germination of wild rice seed[17]. It was found that at continuous concentrations of 0.4 parts per million of dissolved oxygen, seed germination was highest (about 50 percent) but that after germination there was no appreciable growth or chlorophyll formation at this oxygen level. There was some growth at 1.7 p.p.m. and normal growth above 3.0 p.p.m. It appears, therefore, that low oxygen levels aid in breaking the dormancy of the seed but after germination at least moderate amounts of oxygen in the water are needed for further growth. This situation might be expected for in winter the shallow water of rice lakes, or at least the layer of water next to the soil, is usually devoid of dissolved oxygen. In spring the water is aerated by wave action or flow of water.

Under the conditions of the experiment about 25 percent of the rice seeds germinated and grew at favorable oxygen levels. This result is similar to an earlier test made of seed stored over winter in a spring and to that found by Mr. Algot Johnson for seed used in planting his paddy at Washkish.

Observations made on wild stands suggest that some of the seed does not germinate the first year and may lay on or in the bottom mud for at least five years--especially if water levels are high. Delayed germination of seeds of wild plants--especially upland weeds--has long been known.

In Minnesota wild rice is not found in waters high in alkali or sulfate salts. There are no large stands in waters in which the concentration of sulfate ion exceeds 10 parts per million. Waters with concentrations greater

than this are found mostly in that part of the state that was originally prairie--in the southwest and extreme west. Plantings in such waters have failed to produce stands. Even though there may be some growth the first season such stands have not perpetuated themselves. The dividing line between the area having wild rice and that not having it is often quite sharp. It is a matter of a few miles in the Detroit Lakes area. The physiology of this relationship is unknown but it may be due to magnesium toxicity, since magnesium is commonly associated with sulfates, or may be due to the breakdown of sulfates to hydrogen sulfide in the submerged soils.

In Minnesota the fairly sharp separation between carbonate waters in which wild rice grows well, and sulfate waters is mostly a matter of geology and soils. Rainfall and evaporation are also concerned and sulfate waters are characteristic of semi-arid and arid regions--such as those that are characterized by prairie grasses.

Wild rice usually grows on submerged organic soils, especially those that are decayed and somewhat mucky and which contain lime (often evidenced by snail shells in them). Often such soils overlie a hard bottom of sand and clay. Best sites for paddies are often in old glacial lake beds where muck overlays lake clays. In rivers, however, it sometimes grows on sand and silt.

Natural distribution and ecology of wild rice

There are two generally accepted species of wild rice, Zizania aquatica of eastern North America, and Zizania latifolia of eastern Asia, especially Manchuria. Wild rice is not native of western North America, central Asia or Europe. The disrupted distribution illustrated by the two species of wild rice is worthy of comment for there are a considerable number of plants that are distributed in the same way--plants for which the identical or closely related species are found only in eastern North America and eastern Asia. Examples are the tulip tree, sassafras, moonseed, aralias, lopseed, blue cohosh and May apple. They are remnants of an ancient--probably Cretaceous--flora that once had a continuous distribution but which now has this disrupted pattern.

This disrupted distribution pattern is mentioned to point out that wild rice is an ancient kind of grass that antedates man and his ability to distribute it by planting. Although Indians may have, and probably did, plant some North American stands, the original distribution must have come about in other ways.

In North America wild rice grows as a wild plant from Manitoba eastward across southern Canada to New Brunswick. In the central part of North America its southern limit is Kansas and Virginia, but it extends southward along the Atlantic Coast to Florida and along the Gulf to Louisiana. Its greatest abundance, however, is in the Great Lakes area, especially in Minnesota, Wisconsin, Michigan and southern Ontario and Manitoba--areas in which the topography and drainage have been molded by continental glaciation in fairly recent Pleistocene time. It has been planted, with varying degrees of success, in many other places, primarily as a waterfowl food plant.

In Minnesota it is most common in the northern half of the state along moderate-sized slow-flowing streams and in shallow lakes lying in poorly drained topography. Often the lakes containing it occupy shallow depressions in the basins of former larger glacial lakes or lie in quite level ground-moraine country. Some of the streams along which wild rice grows occupy old

glacial drainage channels. Drainage outlets and streams flowing from lakes are often inadequate to carry away excess water in years of heavy snowfall or high spring rainfall with the result that water levels fluctuate considerably. This fluctuation eliminates such perennial plants as cattails, reeds, and sedges that compete for space with wild rice and which can eventually displace it. With the return of lower water levels wild rice can grow without competition. Basically such water level fluctuation sets back plant succession to an early stage favorable to the annual wild rice--a situation generally similar to cultivation of upland soils.

Some of our present wild rice stands are known to have existed nearly as long as there are historical records for the state--some for more than 300 years. Early explorers and fur traders noted that the crop often failed because of high water and this resulted in difficult times for Indians who depended upon wild rice for food. Recent histories of several Minnesota stands indicate that, on the average, a stand can be expected to produce one bumper crop, two fair crops and one failure in a four-year period. Statewide during the past 30 years the crop has varied from a few thousand to over a million pounds of processed rice.

Management of natural stands for maximum production of wild rice should take into account both the natural ecological trends in wild rice lakes and meet the requirements of the wild rice plant. Water level control structures for wild rice stands should allow a wide range (4 to 5 feet) of water level control so the perennial "weeds" can be eliminated occasionally by holding the water high for a growing season. The channel below such dams must often be enlarged so that it is adequate to carry off excess water when this is not wanted. The best operation for production years is to hold the water level in spring so that as much of the water should be dropped slowly --about six inches--throughout the summer. Rapid fluctuations in water level should be avoided in early summer when the wild rice is in the floating-leaf stage. At that time a rapid rise of 6 inches to 1 foot, especially if combined with storms and heavy wave action, can cause the plants to pull and drift ashore and the crop to fail.

Installation of a dam alone on a wild rice stand to try to maintain "stable" water levels is of no avail and may even injure the lake for wild rice production. This happened on several Minnesota lakes in the 1930's when dams were constructed by work relief agencies before we had our present understanding as to the requirements of this wild crop.

It has been pointed out that natural distribution of wild rice antedates man and that its occurrence and abundance is related to fluctuating water levels and chemical requirements of the plant. We have not, however, answered the question "How did wild rice get to places where it now grows?" Along streams the seeds and whole plants, if torn loose, can be washed down stream, but isolated lakes and headwater areas must have been seeded in some other way. Some plantings were undoubtedly made by Indians. The Chippewas have folk tales about one Wah-nah-boo-shu, who discovered how tasty wild rice was in soup and planted all the lakes he knew[5,13]. The most likely natural method of seeding isolated stands appears to be transportation by ducks. It is postulated that such planting occurs, not by the passage of seeds through the digestive tract, as with many hard-seeded aquatic plants, but by the grain being carried in the crop. Ducks will gorge themselves on the seeds and these remain unharmed in the crop for some hours. If such a duck were killed by a mink, falcon or turtle on

another water area, seeding could easily occur. By this method the seed would also be kept moist and viable while being transported.

Wild rice and Indians

Much has been written on the use of wild rice by Indians, their methods of harvesting and use of wild rice as part of their cultural pattern. This is discussed in the papers of Jenks[2], Steeves[13], and Taube[18]. Under aboriginal conditions wild rice made up perhaps a quarter of the food of the Indians of the Lake States. Dr. Jenks was of the opinion that these Indians did not develop an agricultural economy because of the availability of this native grain. Some of the cultural patterns associated with wild rice are the basis of our present legal regulations applying to harvesting.

The Indians as tribes, clans and smaller groups had certain proprietary interests in wild rice stands. Village sites were often near such stands and there was considerable fighting between the Chippewas and the Sioux for possession of them. The concept of property rights among primitive Minnesota Indians is discussed by Hickerson[7]. Larger harvesting operations were often supervised by a tribal chief or an experienced harvester who acted as a "wild rice chief". For example, David Stanchfield[15], a pioneer lumberman, tells how the Chippewa at Mille Lacs under Chief Hole-in-a-Day organized the harvest on nearby stands--stands which are still harvested. Here the standing stalks of ripening rice were gathered together and tied into sheaves on the stand, each family being allotted four to five rows of sheaves across the lake. When all the rice was ripe, the sheaves were untied and the grains knocked into a boat. In this way loss from shattering and to birds was greatly reduced. The processed grain was stored for winter use in birch bark packages called "mokaks", each holding a half to a bushel. It is likely, however, that much Indian harvesting was done by the present method of poling a boat through the stand and knocking the seeds off with short wooden flails.

The Sioux were driven from the Minnesota wild rice range by the Chippewa by 1850 and then the Chippewas were moved to reservations. Under the provisions of several treaties, they often were provided with lands containing sizeable wild rice stands. Some of these stands, such as Nett Lake in St. Louis County and Lower Rice Lake in Clearwater, are still under the control of the Chippewa tribe and only Indian harvesters are permitted. It should be noted that most Minnesota Indian reservations (all except the Red Lake and Nett Lake Lake Reservations) were established as "open" reservations on which individual Indians could sell lands allotted to them. Here much of the land is now in the ownership of whites and for such open reservations the Minnesota Wild Rice Law, passed in 1939, stipulates that within the original boundaries of these open reservations harvesting shall be restricted to Indians and white residents of the reservation.

The Wild Rice Law also tried to perpetuate the Chippewa system of having a Wild Rice Chief supervise the harvest on each stand--the chief being replaced by a local "committee". This has been tried on many stands and is still used on some. However, it has often proven unworkable because there is no provision for paying committeemen and most of them prefer to take part in the harvest rather than supervise it. As a result most of the field direction of harvest is by paid employees of the Conservation Department, especially Conservation Officers.

Harvesting is restricted to Indians on tribal lands and on several of the stands controlled by the U. S. Fish and Wildlife Service. These stands usually total about 6,000 acres or a fifth to a third of the harvested area in any year.

The stands on Fish and Wildlife Service lands are managed both for rice production and waterfowl use. In 1963, for example, 138,000 pounds of rice (non-processed) were taken by Indians from the Tamarack Refuge in Becker County and Rice Lake Refuge in Aitkin County.

The harvesting technique permitted under Minnesota law preserves the traditional Indian method, requiring that on public waters hand flails and small hand-operated boats be used.

Indian and white harvesters have long recognized that there are different kinds or strains of wild rice. The rice that grows along rivers, especially on sandy soil, is usually small-grained and ripens early. It is often known as "bird" or "river" rice. Some of the best rice for purposes of harvesting salable grain grows in Nett Lake on the Nett Lake Indian Reservation, and the Indians here are very protective of this choice long-grained rice as a seed source. Other qualities and differences in wild rice have also been noted. For example, in the early 1940's Paul LaRoque, a Chippewa Indian who was then Assistant Director of the wild rice harvest, commented that as a boy he had harvested wild rice with his grandfather on Big Rice Lake near Remer in Cass County, and this rice was known to the Indians as "double-jacket" rice because the hulls on the grain were especially thick and hard to remove. The wild rice grown on different stands is sufficiently different so that an experienced buyer can often tell where it came from by looking at it.

Yields and harvests

As previously noted, under hand harvesting methods required by Minnesota law, the harvest of wild rice usually does not exceed 100 pounds of non-processed (commonly called "green") rice per acre and 40 pounds of processed rice. Some recent information on this comes from Mr. Jay Janacek, Game Manager at Grand Rapids, Minnesota, who has gathered information on wild rice harvesting on the Mud-Goose Lake area near Ball Club. In 1967, a year of good crops here and high prices, the harvest amounted to 62 pounds per acre (green rice) for the 1600-acre area from which the rice was taken. Using a factor 1 pound of processed rice from 2.5 pounds of green rice this is equivalent to 25 pounds of processed rice per acre. The usual harvest in Minnesota in recent years has, as determined from reports of buyers and processors, been about 2 million pounds ("green") and this has ranged usually between 1 million and 3 million.

The rice harvested from wild stands represents only a small fraction of the crop, even if the stands are harvested several times. This proportion has been variously estimated at between 5 and 25 percent 1,4,8/ .

In an experimental 40-acre paddy at Washkish, Mr. Algot Johnson's 4/ use of a mechanical harvester combined with hand Indian harvesting took 370 pounds (green) rice per acre (150 pounds processed) and this, he estimated, represented only about one-third of the total crop. Rogosin 10/ by expanding yield data from rice grown experimentally in small boxes calculated total yield of 22 to 129 pounds per acre (processed) for unfertilized soil and 150 to 537 for fertilized soil. He found the yield was related to density of planting of seed. The highest returns from seed planted were 14-fold on fertilized soil planted at the rate of 160,000 grains per acre and 5-fold from fertilized soil planted at the rate of 1,600,000 grains per acre. Since there are 5,000 to 9,000 grains per pound of seed (Washkish data of Mr. Johnson) these represent returns from planting about 20 to 200 pounds per acre. There is no accepted standard weight in pounds for a bushel of non-processed wild rice, this varying greatly with the moisture content of the grain and the hulls and the proportion of filled grains, but, roughly, these two planting rates can be

considered to be one-half and five bushels per acre. It might be noted that seed wild rice is usually sold by the quart by aquatic nurseries and that for wildlife plantings a bushel (32 quarts) per acre is often used. Samples of "green" rice collected by the Minnesota Department of Agriculture in 1966 ranged in air-dry weight from 13.6 to 22.7 pounds per bushel with an average of 17.1 pounds--roughly half that of oats.

In summary: (1) hand harvesting takes only a small part of the crop from wild stands and usually this harvest amounts to 40 pounds or less (processed rice) per acre; (2) under intensive management and careful harvesting a yield of 150 pounds per acre is possible from wild strains. With a non-shattering strain, fertilization and intensive harvesting a yield of 500 pounds per acre could be produced if all the grain were harvested. Brooks[1] gives a more optimistic estimate of 1500 to 1800 pounds per acre; and (3) planting rate for greatest return from seed planted is probably around one bushel (32 quarts dry measure or 40 to 50 pounds) per acre and for greatest overall yield, on fertilized soil, about 5 bushels per acre.

The wild rice industry

Wild rice remained principally an Indian food of not much commercial importance until after 1900. However, in the early days some was bought by fur trading companies to augment the food supply at their posts. For example, in the early 1800's the Northwest Fur Company bought 1200 to 1500 bushels a year in the Rainy Lake area[13]. In later years some was purchased or traded to local white residents and logging camps. According to L. A. Rossman[11], pioneer newspaper publisher at Grand Rapids, the first commercial dealer in wild rice in Minnesota was Frank Vance, who had a store near Squaw Lake in Itasca County. He bought green rice from the Indians at a cent or a cent-and-one-half a pound, and finished rice for 5 cents a pound. This he sold "almost uniformly" for 10 cents a pound. He also developed the first mechanical processing equipment. He sold 5 or 6 tons a year. Mr. Rossman gives no exact dates but this was prior to World War I, probably around 1900-1910. During World War I the price of finished rice rose to 30 or 40 cents a pound, and others went into the business. Some constructed harvesting machines, boats with reels like that of a grain binder, to knock the grains into the boat. Photographs of machines of this type used in Manitoba more recently are shown in Steeve's paper[13].

In 1939 the use of such mechanical "pickers" on public waters was outlawed in Minnesota and in that year the Conservation Department put the wild rice law into effect and supervised the harvest. There was difficulty in organizing the harvest and in 1940--a year of a bumper crop--the first survey of the stands was made by the writer and the harvest better organized. Green rice then sold for 5 to 6 cents a pound and finished rice for about 15 cents. In years of ordinary crops, however in the 1940's the rice usually sold on the stands for 8 to 15 cents a pound. Processed rice wholesaled at 30-40 cents and retailed at 50-60 cents a pound[11].

Demand for wild rice as a culinary novelty and gourmet food has increased greatly since then--at least partly due to activities of the processors who early organized a Wild Rice Producers Association. Processing methods have been improved and the product made more attractive to the customer. In recent years wild rice has commonly retailed from $4.00 to $5.00 a pound. The retail price hit a peak of about $8.00 a pound in some places in 1966, following three years of mediocre crops. In recent years prices paid to harvesters on the stands have usually been in the range of 35 to 75 cents a pound, but in 1967 soared to between $1.00 and $1.75.

Between 1939 and 1953 the number of licensed harvesters ranged from 292 to 2514. In 1960 there were 10,486 licensed wild rice harvesters in Minnesota and 285 licensed buyers. In 1967 there were 15,750 licensed harvesters and in 1968, 16,443.

SELECTED BIBLIOGRAPHY ON WILD RICE

1. Brooks, Erwin R.
1966. (not dated) Wild rice and the wild rice industry--present and future. Manomen Development Co., Deer River, Minn. 27 pp. mimeo. (Considers prospects for development as commercial crop.)

2. Hickerson, Harold
1967. Land tenure of the Rainy Lake Chippewa at the beginning of the 19th Century. Smithsonion Inst. Cont. to Anthropology. Vol. 2, No. 4, 61 pp. (Indian use and conceptions of property rights.)

3. Jenks, A. E.
1900. The wild rice gatherers of the upper lakes. 19th Ann. Rept. Bur. Ethnol. for 1897-98. Washington: GPO. Pt. 2, 1013-1157. (Indians and wild rice.)

4. Johnson, Algot F.
1962. Cultivating wild rice. 2 pp. mimeo. Dec. 28. (Experiences at Washkish.)

5. Kaufman, J. W.
1938. Wild rice. Nature Notes, Minneapolis Public Library, Vol. 1 No. 8; pp. 7-10. (Wild rice in Minnesota in the 1930's; folklore.)

6. Moyle, John B.
1944. Wild rice in Minnesota. Jour. Wildl. Mgt. Vol. 8, No. 3 pp. 177-184. July (Summary of investigative work including characteristics of plant and grain.) Bibliography.

7. Moyle, John B.
1956. Wild rice--pioneer food and modern delicacy. Minn. Cons. Volunteer, Vol. 19, No. 109, pp. 11-14. Jan.-Feb. (Summary of Minnesota data to 1956.)

8. Moyle, John B. and Paul Krueger
1964. Wild rice in Minnesota. Minn. Cons. Volunteer, Vol. 27, No. 158, pp. 30-37. Nov.-Dec. (Summary through 1963; a mimeographed edition of this includes a listing of the principal stands.)

8a. Oelke, E. A. and W. A. Brun
1969. Paddy production of wild rice. Univ. Minn. Ag. Ext. Serv. Fact Sheet Agronomy No. 20, 2 pp.

9. Rogosin, Alfred
1954. An ecological history of wild rice. Univ. of Minn., Dept. of Botany, 29 pp. mimeo. (Summary of ecological aspects, good bibliography.)

10. Rogosin, Alfred
1958. Wild rice growth and production in relation to water level, seeding, density and fertilizer application in northern Minnesota. A progress report. Univ. of Minn., Dept. of Botany, 8 pp. mimeo. (Data on experimental yields.)

11. Rossman, L. A.
1939. Wild rice Grand Rapids, Minnesota. 15 pp. (Early history of commercial wild rice industry in Minnesota--copy in Minn. Cons. Dept. Library.)

12. Stanchfield, Daniel
1901. History of pioneer lumbering on the upper Mississippi and its tributaries with biographic sketch. Coll. Minn. Hist. Soc. Vol. 9, pp. 325-362. (Early harvesting in Mille Lacs area.)

13. Steeves, Taylor A.
1952. Wild rice--Indian food and a modern delicacy. Economic Botany Vol. 6, No. 2, pp. 107-142. April-June (Good summary and extensive bibliography.)

14. Stoddard, Charles H.
1956. Utilization of waste swamplands for wild rice production. Land Economics, Vol. 33, No. 1, pp. 77-80. Feb.

15. Stoddard, Charles H.
1960. Wild rice production from new wetlands. Trans. 25th North American Wildl. Conf., pp. 144-153. (Use of waste swamplands for growing wild rice.)

16. Supreme Court of the United States, October term
1922-25. Transcript of record of the United States of America vs. the State of Minnesota. Filed May 7, 1932. 458 pp., maps. (Data on early use by Indians.)

17. Svarre, Carl W.
1960. The effects of various oxygen levels on germination and early development of wild rice. Minn. Dept. Cons., Div. Game and Fish, Game Inv. Rep. No. 3, 11 pp. mimeo.

18. Taube, Edward
1951. Wild rice. Scientific Monthly, Vol. 73, No. 6, pp. 369-375. Dec. (General, mostly historical.)