

## WILD RICE IN MINNESOTA

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Wild rice (*Zizania aquatica*) is an aquatic grass of the Tribe Zizanieae which produces grain valued as food for waterfowl and as a table delicacy for mankind. It is a native plant and not the ancestor of the cultivated rice of commerce. Wild rice grows throughout the eastern half of the United States and adjoining portions of Canada (Hitchcock, 1935), but is more abundant in central and northern Minnesota than in other parts of its range. Minnesota wild rice stands are autumn feeding grounds for waterfowl on the Mississippi flyway. Martin and Uhler (1939) report that this rice formed 5.10 per cent of the food in the stomachs of many game ducks taken in the eastern United States, and Morse (1941) found it made more than 50 per cent of the food for wild ducks on some Minnesota lakes in autumn. Wild rice has long been gathered for food by the Minnesota Indians and at present is harvested in considerable amounts by both Indians and whites.

### ECOLOGY OF WILD RICE

Wild rice grows in shallow lakes and along streams in water 1 to 3 feet deep. The seeds, buried in the bottom mud since the preceding autumn, germinate in May and June to produce ribbon-like submerged leaves. By late June and July these leaves have grown to float on the water surface. The blossom stalks emerge during the first 2 weeks in July, and when a few inches above the surface begin to flower; the stalks continue

to grow until the grains are nearly mature. At the time of ripening, in late August and September, the "straw" extends 2 to 8 feet above the water. Each stalk produces a terminal panicle of unisexual spikelets—pistillate on the upper ascending branches and staminate on the lower spreading branches. The pistillate portion matures from the top downward and about 10 days are required for the ripening of all the seeds. Around each kernel is a hull of the persistent palea and awned lemma. When fully mature, the entire spikelet disarticulates from the pedicle, drops into the water, and settles into the bottom mud. Most wild rice plants have but one stalk with a terminal panicle or "head," but stooling may occur in shallow water when an individual plant will produce five or six stalks.

Wild rice usually grows in nearly pure stands. The lakes producing this crop show marked seasonal differences: in spring they are expanses of open water, in midsummer covered with a mat of floating leaves, and in late August and September resemble fields of cultivated grain. The vegetational complex of wild rice stands is essentially one of annual development. The aquatic plants usually associated with this grass begin growth each season from seeds, winter buds, or other types of propagules. Rooted perennials are uncommon. In Minnesota the most common aquatics associated with wild rice are bushy pondweed (*Najas flexilis*), coontail (*Ceratophyllum demersum*), duckweeds

(*Lemna minor*, *L. trisulca* and *Spirodela polyrhiza*), bladderwort (*Utricularia macrorhiza*), and a pondweed (*Potamogeton zosteriformis*). The bushy pondweed is especially abundant in some stands and, like the wild rice itself, is avidly eaten by waterfowl (Morse, 1941).

In Minnesota, the chemical nature of the water seems to be the principal factor affecting the natural distribution of wild rice. This crop tolerates the entire carbonate (total alkalinity) range of Minnesota waters (5 to 250 p.p.m.), but is intolerant of sulphates. No large stands of rice occur in waters having a  $\text{SO}_4$  content greater than 10 p.p.m., and rice generally is absent from water with more than 50 p.p.m. Best growth is made in carbonate waters having total alkalinity greater than 40 p.p.m. Most Minnesota wild rice stands are on mucky soils over gravel or sand. The crop grows best in lakes having some water moving through and often is lacking from stagnant lakes and pools, especially bog lakes with dark brown water. It is frequent along streams and at lake inlets and outlets.

#### THE CROP AND ITS HARVEST

Surveys in 1940-42 showed at least 15,000 acres of wild rice in stands of 5 acres or more; the total probably would approach 30,000 acres if all smaller stands were considered. The stands vary from small patches fringing lakes and creeks to nearly 1,000 acres in some large shallow lakes; about 150 are large enough to warrant harvesting. The principal stands of more than 500 acres each are in Nett Lake, Koochiching County; Upper and Lower Rice lakes, Clearwater County; Star Lake, Otter-

tail County; Lake Minnewawa, Aitkin County; and Big Rice Lake, Cass County.

The Minnesota harvest (calculated from returns by about 10 per cent of the harvesters), was 1,586,000 pounds, or 793 tons of parched or processed grain, in the bumper crop of 1940. In 1941 only 20,000 pounds were taken but in 1942 the harvest was 337,000 pounds, about 75 per cent of normal (estimated annual production of processed rice about 500,000 pounds). The poundage of non-processed grain was 2.5 times the foregoing figures. In 1940, 2,500 persons were engaged in the harvest. In most years the grain has a gross sales value between \$100,000 and \$400,000. The price paid on the stands for non-processed rice in 1940 to 1943, was 5 to 12 cents a pound. During the same period processed rice brought 20 to 40 cents a pound on the stands and retailed in Minnesota at 40 to 60 cents per pound. In addition to the processed rice sold for table use, considerable amounts of non-processed grain are purchased by aquatic nurseries and sold to sportsmen for planting as a waterfowl attraction.

#### HISTORY OF RICE HARVEST

Wild rice has long been harvested by the Minnesota Indians and prior to the coming of the white man was one of their staple foods. Before 1800, most of the stands were controlled by the Sioux; the Chippewas, now the bulk of the state's Indian population, then inhabited only the north shore of Lake Superior. The earlier and more general use of firearms by the Chippewas and the pressure of white settlement on both tribes, allowed the Chippewas to gain control of most of the wild rice be-

tween 1820 and 1860. Later these Indians were settled on reservations, most of which included or were close to the more important rice stands, and until recent years they have harvested most of the grain. At present, about one-third of the licensed harvesters are of Indian blood. In 1888 it was estimated that wild rice comprised a quarter of the food of the Winnibigoshish, Cass, and Leech Lake Chippewa bands (U. S. Supreme Court Transcript, 1922, p. 160). Estimates of the harvest between 1861 and 1909 by Indian agents (Jenks, 1898; Winchell, 1911) suggest that probably not more than 6,000 or 7,000 bushels were harvested each year by the Indians and in most years the harvest was considerably less. At least twice as much wild rice probably now is harvested annually as was taken formerly by the Indians.

#### HARVESTING AND PROCESSING

The primitive Indian method of harvesting, as related by Jenks (1898) and as described to the writer by older Chippewas, involved sheaving or tying the standing heads. The standing sheaves then remained on rice beds until all of the kernels matured. The harvester then would pole through the stand, bend the sheaves over the edge of the canoe, untie the heads, and knock off the grains with a short flail. When a boatload was gathered, it was taken ashore, spread on blankets for a day or two to dry, and then heated and stirred in a large iron kettle until the hulls were brown and brittle. Often the heating was continued until most of the grains were popped. This heating process is called parching. Threshing was accomplished by dancing on or beating

the grains with poles until the parched hulls were loosened. The grain was then separated from the hulls by winnowing. In recent years, binding the heads into sheaves has been abandoned, both because of the labor involved and of the ease with which such rice can be pilfered by less industrious harvesters. Rice now is harvested by poling a narrow flat-bottomed boat through the ripening stand and knocking the ripe grains into the boat. Harvesting is generally a family affair. The man usually stands in the rear to shove the push-pole and the woman, seated in the middle, gathers armfuls of the stalks with aid of a tapered stick 2 to 3 feet long, bends the heads over the edge of the boat, and taps them lightly with a similar stick to remove the ripened grain. Since the heads ripen over a 10-day period and the kernels fall as they ripen, each stand must be harvested several times to get even a small percentage of the crop. Stands usually are harvested four times at 2-day intervals.

The primitive processing now is used by only a few of the older Indians. Most of the rice is processed with simple homemade machines. A common device for parching consists of a steel oil barrel rotated over a low wood fire on a central iron shaft through the barrel that terminates in a crank. Threshing is done with another barrel fixed horizontally on a platform; centered in this barrel is a revolving shaft carrying eccentric paddles shod with pieces of old automobile tire casing. On the end of the shaft is a pulley, belted to a gasoline engine or to the rear wheel of a jacked-up automobile. The hulls are removed as the grains are thrown back and forth against the paddles. An ordinary farm

fanning mill is commonly used for winnowing. In the larger ricing camps there usually is a division of labor and certain individuals spend most of their time at processing the grain.

Much of the wild rice now harvested is sold to commercial processors as it comes from the stands. These firms have developed better mechanical means for processing the grain and can produce a more uniform finished article. The rice usually is heated only until the hulls are brittle enough to thresh and the grains not popped, as often occurs in hand processing. Popped grains tend to fragment and make a less attractive product. Machines for harvesting wild rice have been devised but are no longer allowed on Minnesota stands because the harvesting is being maintained as a self-perpetuating hand industry. A harvester used with some success is a flat-bottomed motorboat with a mechanically-operated reel on the front, similar to that of a grain binder, to knock the grains from the heads into the boat.

#### VARIABILITY OF WILD RICE

Two kinds of wild rice have long been recognized by plant taxonomists: a tall, robust, wide-leafed type (*Zizania aquatica*) and a shorter, narrow-leafed rice *Z. aquatica* var. *angustifolia* (Hitchcock, 1935). In Minnesota stands much of the material appears to be intermediate, although both varieties can be found. Plants fitting both descriptions frequently occur in a single stand. In general, var. *angustifolia* is commoner in the softer waters of northeastern Minnesota (total alkalinity less than 50 p.p.m.) and the taller *Zizania aquatica* is more characteristic of the harder waters of the southern and western parts of the wild rice area.

Distinct strains of wild rice occur in many Minnesota beds, and an experienced buyer often can tell from a sample of grain the stand which produced it. Detailed examination of the more important stands in 1940, 1941, and 1942 showed them to differ markedly in the average size and number of kernels per head, and these characteristics were fairly constant from year to year. This is generally recognized by harvesters of wild rice and some areas, such as Nett Lake and Lake Minnewawa, have long been famous for the large kernels produced.

The length of the kernel or spikelet, from base of spikelet to base of awn, commonly varies from 6 to 20 mm. The averages, for length of kernel, from 85 stands were as follows:

Average length, millimeters	Number of stands
8	2
9	3
10	2
11	9
12	10
13	14
14	14
15	18
16	5
17	1
18	7

The average length of kernels for all stands was 13.6 mm. Strains with kernels 15 to 18 mm. long are sold by aquatic nurseries as "giant wild rice," and those shorter than 10 mm. are known as "bird or river rice." The average number of kernels per head was 15 to 212 on the 50 stands examined:

Average kernels per head	Number of stands
15 to 50	17
51 to 100	18
101 to 150	14
151 or more	1

The grains and grain scars on a dozen or more typical heads from each stand were counted. The leaves varied from

under 10 mm. to about 30 mm. in width. Variation also occurs in the length of awn and color of the heads. Most maturing heads are green but nearly every stand has a sprinkling of purplish heads; the grain produced by the two color phases, however, is identical. The height of mature stands above the water surface was 2 to 8 feet.

Different stands exhibited nearly every combination of these variable characteristics, but the shorter, narrow-leafed rice generally produces fewer and larger grains than the taller, wide-leafed type. All stands producing grains that averaged 18 mm. in length had panicles with fewer than 50 kernels and had or approached the growth form of var. *angustifolia*. This type is most valued by the harvester because the large grains and short straw facilitate harvesting from a boat.

There is considerable variation in the number of days required to mature the crop. The first stands begin to ripen about August 18 and the last about September 12; most of them begin between August 24 and September 3, the greatest number usually ripening about September 5. Since about 10 days are required to complete the ripening, most of the harvesting occurs between August 25 and September 12. Ripening dates are fairly constant and do not vary more than 2 or 3 days in any stand over a period of years. The first to ripen has both short straw and small grains; the taller rice and that with more grains per head, generally is later.

The most distinct strains are found either in small isolated stands or in the large continuous stands of the general rice area; their natural development may be attributed to self-pollination over a long period of years. The age of

most Minnesota stands is not known, but harvesting has been carried on regularly in some large beds for at least 100 years.

#### CROP FLUCTUATIONS AND FAILURES

On the basis of harvest data for 24 years at Nett Lake in Koochiching County, for 21 years at Platte and Sullivan lakes in Morrison County, and for shorter periods on other waters,<sup>1</sup> the harvest during any 4 years is likely to fail once, and to produce one bumper and two fair crops. Jenks (1898) gathered considerable evidence on harvest failures and reached the same conclusion as to their frequency. Failure results mainly from high water during June and July. The best crops occur in years of sub-normal rainfall with receding water levels. Comparison of the water levels in 1940 (bumper crop) and in 1941 (poor crop) shows that a water stage 12 inches or more above normal during the period from May 15 to July 1 caused a failure and a stage 6 inches above normal reduced the harvest on some stands by more than half. Lake Minnewawa, Aitkin County, had a water stage 6 to 8 inches higher in 1941 than in 1940 and suffered a reduction in harvest from 60 tons to less than one ton.<sup>2</sup> Continued high water when the plants have only submerged leaves results in such weak, attenuated growth that the plants are easily destroyed by

<sup>1</sup> Data for Nett Lake from memorandum by S. D. Walker to M. L. Burns, Acting Superintendent, Consolidated Chippewa Agency, Cass Lake, Minnesota, Sept. 15, 1939. Data for Platte and Sullivan Lake from Walter Zak, Hillman, Minnesota (letter, Dec. 29, 1941).

<sup>2</sup> William Simpson (letter Sept. 11, 1941) to the Division of Drainage and Waters, Minnesota Department of Conservation.

wave action and adverse weather (Chambliss, 1940). This phenomenon is locally known as "drowning." Heavy wind, hail, and rain storms while the kernels are maturing also bring about failure or reduction of the harvest by lodging and uprooting the plants.

In some years many of the rice flowers do not set grains. The cause is unknown but usually is attributed to hot, dry weather when the plants are in flower. Eleven of the 14 stands observed in detail during 1941 produced heads on which less than 50 per cent of the spikelets matured. Rice harvested from such stands is light in weight and the sterile grains must be removed by water flotation before it can be processed.

The army worm (*Agrotis* sp.) occasionally destroys limited amounts of wild rice near shores by feeding on the maturing grains, and a few grains sometimes are infected with ergot. Stands in southern Minnesota have been destroyed by German carp, and muskrats frequently gnaw off the stems at the waterline.

#### YIELD AND HARVEST

In 1941 an estimate of the total yield was made on 14 stands. Two to 11 representative sample areas were selected on each and delimited by floating wooden hoops, each enclosing an area of 11.5 square feet. The number of areas sampled depended upon the size and the uniformity of the stand. On each area, all panicles were removed and bagged for study. To obtain the total yield per unit area, the following data were obtained from these collections: (1) the average number of panicles per square foot, (2) average number of grains and grain scars per panicle, (3) average

weight of dry grain per square foot, and (4) percentage of sterile spikelets. The 1941 harvest on most stands was regarded as a failure, but all 14 stands produced some rice and averaged 168 (50 to 401) pounds of processed rice per acre.

All these stands were open to harvesting but only two were harvested: Upper Rice Lake in Clearwater County with a total production of 401 pounds per acre, and Big Rice Lake in Cass County with 323 pounds per acre. Harvesting was attempted on some others but abandoned. It seems, therefore, that unless a stand produces more than 300 pounds of processed rice (or 750 pounds non-processed) per acre, hand harvesting is not profitable.

The long record of harvest data for Nett Lake showed the harvest there has varied from 6 to 43 tons, averaging about 15 tons. The stand usually comprises about 800 acres of harvestable rice and has, therefore, an average yield of 37.5 pounds per acre. In contrast, the total production in 1941 (poor crop) was 185 pounds. A crude estimate of the average on all stands can be gained by dividing the average annual take per licensed harvester by the number of acres allotted to him for harvesting. The average allotment is about 10 acres; the average take for 1940 was 393 pounds and for 1942 was 315 pounds. This suggests the usual amount taken as between 30 and 40 pounds of processed rice per acre. Stewart (1926) carefully checked the harvest on a 2,000 acre Minnesota stand and found 50 pounds of processed rice per acre taken in 1924, a good crop year.

Several factors are involved in the marked difference between total yield

and total harvest; most important are incomplete harvesting of individual heads by hand methods and incomplete coverage of the stands by the harvesters. Since several of the best Minnesota stands are known to have been harvested by hand for at least a century, it is evident that such harvesting does no damage to them and leaves most of the grain for waterfowl and reseeding.

#### PROPAGATION OF WILD RICE

Because of its obvious value as an attraction for waterfowl, wild rice has been planted in many waters where it did not occur naturally. Some plantings have succeeded, but more have failed. Of eight made in the wild rice area of northern Minnesota during 1940, four produced good crops, three fair crops, and one failed the following year. Three other plantings during 1940 in waters high in sulphates failed completely. Two earlier seedings in the wild rice area produced fair crops the first year but failed thereafter. Miller (1943) examined the results of 50 plantings of wild rice in Michigan and found that 74 per cent of them failed to become permanent.

The conditions that appear most conducive to success of wild rice in Minnesota are: (1) clear water, 1 to 3 feet deep, with total alkalinity greater than 40 p.p.m. and  $\text{SO}_4$  concentration less than 10 p.p.m.; (2) organic soil 6 inches or more in depth, preferably with some calcareous material such as snail shells; (3) some movement of water through the area; (4) fluctuation of water level less than 6 inches throughout the growing season; and (5) absence of carp. Almost all such waters within the wild rice area now have rice, and planting is

usually advisable only when stands have been destroyed by drought or a long period of fluctuating water levels.

Since wild rice is available as waterfowl food only for about a month and provides good shelter for only about 2 months each year, it is less desirable as a food species than the pondweeds (*Potamogeton*) and less desirable for cover than the perennial bulrushes (*Scirpus*). It does, however, provide much excellent food during the autumn waterfowl migration and therefore is one of the most effective aquatic plants to attract and concentrate waterfowl.

Wild rice seed should be kept cool and moist from the time it is harvested until planted; two methods of storage have been found to be effective. It can be stored in double burlap sacks encased in cages of chicken wire and submerged in a lake; the wire excludes muskrats, which have a great liking for the seed. Seed also can be stored in a cool root cellar in double burlap sacks, so arranged that water from melting ice will drip upon the sacks continuously and keep the seed moist.

Planting is best done from a boat or canoe. The seed should be scattered over the surface of waters that are 1 to 3 feet deep in depth. All good seeds will sink to the bottom immediately. The best rate for seeding is about 1 bushel per acre or, in small areas, a large handful to an area 6 by 6 feet. Preferably, plantings should be made a short time before ice forms in fall or as soon as the ice breaks up in spring.

#### SUMMARY

Minnesota contains more than 15,000 acres of wild rice (*Zizania aquatica*) growing in shallow lakes and along



streams in the northern and central parts of the state. This native, unimproved grain exhibits considerable variation in the size and number of kernels per head and in other characteristics, and it tends to develop local strains.

The crop, in addition to having value for waterfowl, provides an average annual harvest of about 500,000 pounds of processed rice. Up to 2,500 persons, about one-third of Indian blood, engage annually in the harvesting and the grain usually has an annual value of \$100,000 to \$400,000. The grain is harvested by hand methods similar to those long used by the Minnesota Indians. Simple mechanical procedures have now largely replaced hand labor for parching the grain and removing the hulls.

On any stand the harvest will fail, on the average, one year in four, the principal cause being a high water level during May and June. Sufficient grain for reseeding usually is produced in years of harvest failure.

The few data available suggest that often as little as one tenth of the crop on a stand is taken by hand harvesting leaving most of the grain for waterfowl and reseeding. When total production, calculated as processed rice, is below 300 pounds per acre, hand harvesting usually is unprofitable. The average harvest in Minnesota is about 30 to 40 pounds per acre (processed rice).

Wild rice, is more of an attraction

than a staple food plant for waterfowl, and shows marked preference for certain habitat conditions; unless these conditions are supplied plantings are apt to fail.

#### LITERATURE CITED

- CHAMBLISS, C. E. 1940. The botany and history of *Zizania aquatica* L. (wild rice). Smithsonian Inst. Ann. Rep., 1940: 369-382, illus.
- HITCHCOCK, A. S. 1935. Manual of the grasses of the United States. U. S. Dept. Agric. Misc. Publ., 200, 1040 pp.
- JENKS, A. E. 1898. The wild rice gatherers of the upper lakes. Smithsonian Inst. Bur. Am. Ethnology, Ann. Rept., 19 (2): 1019-1131, illus.
- MARTIN, A. C., and F. M. UHLER. 1939. Food of game ducks in the United States and Canada. U. S. Dept. Agric. Tech. Bull., 634, 155 pp., illus.
- MILLER, HERBERT. 1943. Wild rice in Michigan. Mich. Conservation, 12(5): 4-5.
- MORSE, MARIUS. 1941. Duck foods and hunting takes. Conservation Volunteer, 2(10): 34-36.
- STEWART, JOHN T. 1926. Development of wild lands as related to conservation. Fins, Feathers and Fur (Minnesota Game and Fish Dept. Bull), 45: 72, 73, 79.
- 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.
- WINCHELL, N. H. 1911. The aborigines of Minnesota. A report based on the collections of Jacob V. Brower and the field surveys and notes of Alfred J. Hill and Theodore H. Lewis. St. Paul, Minn. Historical Soc. 761 pp., illus.