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Status Survey for *Ophiogomphus anomalus* Harvey, and early-season dragonfly inventory of western Superior National Forest Rivers

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By

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Abstract: Status surveys for the Special Concern dragonfly, *Ophiogomphus anomalus,* were conducted on selected rivers in northeastern Minnesota, along with an inventory of other early-season river dragonflies. *Ophiogomphus anoma*lus were confirmed on the upper St. Louis River in St. Louis County, but no new occurrences were found. Additional evidence of developmental abnormalities in northern Minnesota dragonfly larvae was found at several locations.

Introduction: The objectives of this project were as follows.

1) To continue status determination surveys for one of the Midwest's rarest dragonflies, the globally rare (G3) and state Special Concern extra-striped snaketail (*Ophiogomphus anomalus* Harvey) in northeast Minnesota; to determine the species distribution and habitat preferences on the upper St. Louis, and sample other appropriate sites on the western Superior National Forest and adjacent northeast MN.

2) To develop a scientific basis for conservation and management of *O. anomalus* on National Forest and other lands.

3) To gather distribution data on the other early-season dragonflies that inhabit the undersurveyed rivers of the Superior National Forest and surrounding area.

4) to collect large enough samples at at least two sites that would allow a meaningful comparison to sites where dragonfly abnormalities were documented in a 1998 study by Steffens and Smith

The U.S. Fish and Wildlife Service considers *O. anomalus* a species of concern in region 3 (Refsneider, pers. comm.). Previous surveys in Minnesota have turned up only two sites in the state, the upper St Louis River in St Louis County, and the Pigeon River in Cook County (Montz 1993, Steffens and Smith 1999, 2000).

Ophiogomphus searches in WI have so far revealed only 7 WI waterbodies to have populations of *O. anomalus* (WI NHI,1998, unpublished data) mostly in the St. Croix River drainage. Some of the St. Croix River sites found in WI are directly adjacent to Minnesota, but specimens of the St. Croix River population have yet to be found in MN. Only 3 apparently viable populations are known in WI.

Smith (1995) characterized *O. anomalus* streams relative to average values for all WI streams as follows: large (width 16-180 m.) with substrate composed of lower amounts of sand and muck, and larger amounts of gravel and rock. These streams were also restricted to largely non-agricultural watersheds, and had lower than average alkalinity.
Little is known about the adult lifestage of this rare species. They may spend much of their adult life in treetops, as their close relative *O. howei* does (Smith 1999).

Methods and Materials: Survey sites were chosen for their likelihood of *O. anomalus* habitat, ie moderate sized warm-water streams with moderate gradient and at least some gravel substrate. Aerial photographs, soil maps, and conversations with natural resource personnel were used to determine potential sample sites, which were later field-checked.

All dragonfly exuviae along a 100' stretch of shoreline were collected at each site, except at the abnormality comparison sites, as noted below. Only 80' of shore was sampled at the Vermillion River site 4 miles above Buyck, as darkness prevented further collection. Stream flow, depth, and substrate were recorded at each site. Exuviae were preserved in 70% ethanol, and were later identified using appropriate taxonomic keys (Louton 1982, Needham and Westfall 1955, Walker 1958, Walker and Corbet 1975).

Most sites were chosen based solely on their potential *O. anomalus* habitat. These sites were: 2 sites on the Vermillion River, Two sites on the Stony River, 3 sites on the upper St. Louis River, Isabella River, the Partridge River, and the Pike River. Several of these turned out to have less than optimal *Ophiogomphus* habitat when field checked, but all were sampled anyway.

Two sites were selected for making a comparison to the previous study in which dragonfly abnormalities were found in several northern Minnesota rivers. The selected "comparison" sites were the Vermillion River at Buyck, and the South Kawishiwi River above Highway 1. These sites were chosen for a) their likelihood of having similar species to those found in the 1998 study, primarily *Ophiogomphus*; b) for their likelihood of *O. anomalus* habitat, and c) for their likelihood of producing exuviae in great enough numbers that would allow a meaningful comparison to the 1998 abnormality data. At these two sites, sampling continued until over 200 exuviae were collected. In both cases, this required sampling approximately 150' of shoreline.

Results: *Ophiogomphus anomalus* were found at only one site, a previously known site on the St Louis River at Highway 100, just south of Aurora. The sampling results are shown in Tables 1-7. A brief discussion of each river follows the corresponding table.

Table 1. St Louis River

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
ST LOUIS	MNSTLO	HIGHWAY 100	5/29/00	BASIAESCHNA JANATA	1	T58NR15W	22
				HYLOGOMPHUS ADELPHUS	5		
				HYLOGOMPHUS VIRIDIFRONS	5		
				MACROMIA ILLINOIENSIS	5		
				OPHIOGOMPHUS ANOMALUS	21		
				OPHIOGOMPHUS RUPINSULENSIS	3		
				PHANOGOMPHUS EXILIS	18		
				PHANOGOMPHUS LIVIDUS	44		
ST LOUIS	MNSTLO	FOREST ROAD 130	5/29/00	EPITHECA SPINIGERA	1	T58NR14W	33
				HYLOGOMPHUS SP	10		
				HYLOGOMPHUS VIRIDIFRONS	65*		
				NEUROCORDULIA YAMASKANENSIS	30		
				OPHIOGOMPHUS RUPINSULENSIS	2		
				PHANOGOMPHUS EXILIS	4		
ST LOUIS	MNSTLO	WHITEWATER ROAD	6/16/00	BASIAESCHNA JANATA	1	T58NR14W	31
				CALOPTERYX MACULATA	1		
				DROMOGOMPHUS SPINOSUS	60		
				HYLOGOMPHUS VIRIDIFRONS	7		
				NEUROCORDULIA YAMASKANENSIS	2		
				PHANOGOMPHUS EXILIS	55		
				PHANOGOMPHUS LIVIDUS	5		
				PHANOGOMPHUS SPICATUS	2		
				STYLOGOMPHUS ALBISTYLUS	18		

The portion of the St Louis River that was sampled flows largely through forested areas of the Superior National Forest, and is relatively undisturbed.

Highway 100. The river is about 80' wide and 5' deep, with moderate current. The water is stained. The substrate here is hard to determine accurately due to the dark water, but consists of gravel, rubble, sand and boulders. Rubble and gravel appears to make up the majority of the river bottom. The banks are grassy with alder shrubs. This site lies about 3-4 river miles downstream from the Superior National Forest.

This is one of only two sites where *Ophiogomphus anomalus* has been found in the state. The rest of the river has been fairly well-sampled (Haarstad 1994, Steffens and Smith 1999), so the species may be restricted to an undetermined length (probably less than several miles) of this portion of the river. A single *O. anomalus* exuvia was collected 1 mile downstream from the Highway 100 bridge. Several miles downstream from Highway 100, the substrate turns to unsuitable, sandy river bottom. Upstream, the river is variable in character, but probably becomes too small for *O. anomalus* somewhere above Norway Point.

This site, and the streams and riparian areas within the upstream watershed should be protected and monitored to determine population trends of *O. anomalus*. This site also has a population of wood turtles. The other dragonflies that were found here are all fairly common and widespread in the study area. One species that has been found here in the past (Steffens and Smith 2000) but was not documented during these surveys is *Stylogomphus albistylus*. This diminutive species has been found only along the upper St Louis River, although it is likely that an earlier report of *Lanthus parvulens* in Minnesota (Carrol and Gunderson 1995) is in error and actually represents this species. *S. albistylus* is *probably* more widespread than current data indicates.

Whitewater Road. This was a poor choice for potential *Ophiogomphus* habitat. The river is mostly wide and sluggish here, 120' wide and 2.5' deep, but there are several constricted areas of rapid flow over rock and boulders. The substrate is mostly sand and rubble, with scattered boulders. The remainder of the river botttom is silty-muck. The occurrence of both *Phanogomphus spicatus*, a sluggish water and lake species, along with *Stylogomphus albistylus*, a moving water species, is indicative of the variety of flow conditions here.

Forest Road 130 (Moose Line). Here the river is fast, 70-90'wide and 2-4' deep, and flows through boulder fields. The variety of habitats is limited, as is species diversity. Only 2 *Ophiogomphus* were found, despite considerable effort. *Hylogomphus* were abundant.

The character of the St Louis River is extremely different at the 3 sample sites, despite being separated by less than 10 miles. A canoe-sampling trip along this stretch of the river might turn up other sites for *O. anomalus*, or other species and habitats that went undetected, although canoing this stretch mightbe difficult. The dragonfly fauna of the lower St Louis River is possibly the most diverse in the state north of the St. Croix drainage (Steffens and Smith 1999); this combined with the occurrence of *O. anomalus* on the upper river makes this river one to be protected, studied, and monitored.

Table 2. Vermillion River

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
VERMILLION	MNSTLO	ABOVE FALLS	5/31/00	BASIAESCHNA JANATA	3	T67NR17W	30
				GOMPHURUS VASTUS			
				HYLOGOMPHUS ADELPHUS	30		
				HYLOGOMPHUS VIRIDIFRONS	15		
				MACROMIA ILLINOIENSIS	1		
				NEUROCORDULIA YAMASKANENSIS	2		
				OPHIOGOMPHUS RUPINSULENSIS	1		
				PHANOGOMPHUS EXILIS	82		
VERMILLION	MNSTLO	BELOW FALLS	5/31/00	BASIAESCHNA JANATA	1	" " " " " "	" "
				GOMPHURUS VASTUS	3		
				HYLOGOMPHUS ADELPHUS	**		
				NEUROCORDULIA YAMASKANENSIS	4		
				OPHIOGOMPHUS RUPINSULENSIS	9		
VERMILLION	MNSTLO	BUYCK	5/31/00	GOMPHURUS FRATERNUS	11	T65NR17W	9
				GOMPHURUS VASTUS	45		
				HYLOGOMPHUS ADELPHUS	3		
				HYLOGOMPHUS VIRIDIFRONS	29		
				LIBELLULA JULIA	8		
				MACROMIA ILLINOIENSIS	16		
				NEUROCORDULIA YAMASKANENSIS	4		
				OPHIOGOMPHUS RUPINSULENSIS	70		
				PHANOGOMPHUS EXILIS	36		
				EPITHECA CANIS	1		
VERMILLION	MNSTLO	BUYCK	7/13/00	**STYLURUS SPINICEPS**	1		
				HAGENIUS BREVISTYLUS	1		
				AESHNA SP.	3		
VERMILLION	MNSTLO	4 MI. ABOVE BUYCK	5/31/00	CALOPTERYX MACULATA	1	T65NR17W	35?
				DIDYMOPS TRANSVERSA	2		
				EPITHECA SPINIGERA	2		
				GOMPHURUS VASTUS	62		
				LIBELLULA JULIA	4		
				MACROMIA ILLINOIENSIS	2		
VERMILLION	MNSTLO	4 MI. ABOVE BUYCK	5/31/00	OPHIOGOMPHUS RUPINSULENSIS	45		
				PHANOGOMPHUS EXILIS	58		
				PHANOGOMPHUS LIVIDUS	2		
				PHANOGOMPHUS SPICATUS	6		

**Numerous, but not collected

Vermillion River. Next to the St. Louis, the Vermillion River is the largest of the rivers that were sampled. The watershed is mostly forested, and subjective water quality appeared to be very good at all sample sites. The Buyck site had fair diversity and good abundance for a northern river. This is one of the few rivers where *Gomphurus spp* were found. *Gomphurus* are usually common in large warmwater rivers throughout the upper midwest, but appear to be lacking in many rivers in this study area.

Buyck. The river is 80-90'wide, 4-5' deep, with slow to moderate flow. The substrate is composed of gravel, rubble, sand and silt. Overall, this was one of the best survey sites of the study in terms of habitat and faunal diversity. Common, slow water species such as *Libellula julia* and *Epitheca canis* were present, as well as moderate flow species such as *Gomphurus* and *Ophiogomphus*. This is the only site where *G. fraternus* were found in this study, although it is frequently encountered on other large rivers of the state. Otherwise, none of the species found here are particularly noteworthy.

This was one of the sites selected for comparison of dragonfly abnormality rates. One of the 29 *H. vir*idfrons (3.4%) had abnormally shaped, curved terminal appendages, and 2 of the 70 *O. rupinsulensis* (<3%) had very minor abnormalities; one, a shortened right paraproct (terminal appendage), and the other lacked a lateral spine on abdominal segment 7 (see Appendix).

On a July visit, *Stylurus spiniceps* was collected. This is only the second record for the county. Other *Stylurus* are likely to be found if additional mid-summer surveys are done on northern rivers.

4 miles above Buyck. Here the river is about 150' wide, depth unknown. The substrate is fairly good for *Ophiogomphus*, with about 40% gravel, 40% sand and 20% rubble and boulders. One again, the fauna is quite typical of northern rivers, with only fair diversity but good abundance. Only 80' of shoreline were collected before darkness fell. Several abnormalities were also found in *Gomphurus vastus* (2/62, 3%) and *O. rupinsulensis* (5/45, 11%). A number of *Gomphurus vastus* also had mouthparts with slightly unusual shape, but most of these were consistent with each other and might represent a local variant rather than abnormalities.

The Vermillion River is mostly inaccessible except by boat, and a more intensive sampling effort on the river may be worthwhile. Suitable habitats for *O. anomalus* or other rare species may have been overlooked.

Table 3. South Kawishiwi River.

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
S. KAWISHIWI	MNLAKE	SPRUCE RD TRAIL	6/2/00	BASIAESCHNA JANATA	1	T62NR11W	23
			AND	CALOPTERYX MACULATA	1		
			6/7/00	NEUROCORDULIA YAMASKANENSIS	18		
				OPHIOGOMPHUS RUPINSULENSIS	293		
				HYLOGOMPHUS ADELPHUS	80		

The South Kawishiwi was sampled at the snowmobile bridge off of the Spruce Road, just outside the Wilderness boundary. This site has some of the best Ophiogomphus habitat of any of the survey sites, due to abundant gravel. The site appeared ideal for *O. anomalus*. The river varies from 80-150' wide or more, and looked to be about 3' deep. Flow was moderate, and the substrate included bedrock, boulders, and rubble, but was probably 50% sand-gravel mix. The bank is bedrock. This site had the greatest abundance per foot of shoreline of any of the sample sites. Emergence had just begun on June 2 and only a few specimens were found, so a return visit was made on June 7. Emergence of early-season species was nearly complete by the 7th.

Of the 293 *O. rupinsulensis* that were collected, 13 (4.4%) had abnormalities of some kind (see Appendix). These were mostly of a minor but easily noticeable nature, and included curved terminal appendages, missing lateral spines, misshapen antennae, and misshapen mouthparts. This river flows primarily through wilderness areas, and no obvious threats to the river or water quality were perceived. The high percentage of deformities in such a large sample suggests that something is amiss with dragonfly development in this river.

Table 4. Stony River

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
STONY	MNLAKE	HIGHWAY 1 WAYSIDE	6/2/00	BASIAESCHNA JANATA	3	T60NR10W	28
				EPITHECA SPINIGERA	3		
				HAGENIUS BREVISTYLUS	1		
				HYLOGOMPHUS ADELPHUS	31		
				MACROMIA ILLINOIENSIS	3		
				NEUROCORDULIA YAMASKANENSIS	8		
				OPHIOGOMPHUS RUPINSULENSIS	48		
				PHANOGOMPHUS EXILIS	18		
				PHANOGOMPHUS LIVIDUS	37		
STONY	MNLAKE	FOREST ROAD 424	6/6/00	BASIAESCHNA JANATA	1	T60NR11W	8
				HYLOGOMPHUS ADELPHUS	4		
				MACROMIA ILLINOIENSIS	3		
				NEUROCORDULIA YAMASKANENSIS	8		
				OPHIOGOMPHUS RUPINSULENSIS	25		
				PHANOGOMPHUS EXILIS	43		
				PHANOGOMPHUS LIVIDUS	6		
STONY	MNLAKE	1 MILE BELOW HWY 1	6/6/00	HYLOGOMPHUS ADELPHUS	2	T60NR11W	13
			6/6/00	OPHIOGOMPHUS RUPINSULENSIS	10		
				PHANOGOMPHUS LIVIDUS	6		

Stony River. The Stony River fauna is typical of many medium-sized northern rivers, and rivals some of the larger rivers in diversity. *Hylogomphus adelphus*, *O. rupinsulensis*, and *Phanogomphus* were abundant. The river ranges from 60-80' wide, and is about 3' deep. The substrate is similar at most sites, and is a mix of sand, gravel, rubble, boulders, silt, and muck. One of the 48 *O. rupinsulensis* (< 2%) at the Highway 1 wayside had a deformed antenna.

Table 5. Isabella River

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
ISABELLA	MNLAKE	ABOVE ISLAND RIVER	7/18/00	BASIAESCHNA JANATA	1	T62NR08W	33
				DROMOGOMPHUS SPINOSUS	21		
				EPITHECA SPINIGERA	1		
				HAGENIUS BREVISTYLUS	4		
				MACROMIA ILLNOIENSIS	1		
				OPHIOGOMPHUS RUPINSULENSIS	10		
				HYLOGOMPHUS ADELPHUS	3		
				PHANOGOMPHUS LIVIDUS	1		

The Isabella River was sampled a short way above the confluence with the Island River. The wide river constricts to about 70' wide at a small rapid. The shoreline adjacent to the rapid, and a short distance above and below the rapid were sampled. The river was less than 3 feet deep in the rapid, but probably considerably deeper elsewhere. Access to this river is limited to canoe, and the surveys were conducted in mid-summer in an attempt to collect both early and later species in one trip. While nothing of particular interest was found here, this one-site, one-visit survey was far from comprehensive.

Table 6. Partridge River

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
PARTRIDGE	MNSTLO	HIGHWAY 110	5/29/00	BASIAESCHNA JANATA	1		
			AND	DROMOGOMPHUS SPINOSUS	5	T58NR15W	13
			6/16/00	HAGENIUS BREVISTYLUS	1		
				MACROMIA ILLINOIENSIS	2		
				OPHIOGOMPHUS RUPINSULENSIS	1		
				PHANOGOMPHUS EXILIS	17		
				PHANOGOMPHUS SPICATUS	2		

Table 6. Partridge River. The Partride River is about 60' wide x 4' deep, with moderate flow. Subtrate ranged from sand and boulders to silty muck, primarily the latter. The relatively low diversity in substrate may partially account for the low numbers and diversity found here, but the site appeared to have far more potential than it produced. There may be better habitat further downstream, near the confluence of the St. Louis River.

Table 7. Pike River.

RIVER	COUNTY	SITENAME	DATE	SPECIES	#	TOWNRANGE	SE
PIKE	MNSTLO	HIGHWAY 26	5/31/00	BASIAESCHNA JANATA	2	T61NR16W	26
				MACROMIA ILLINOIENSIS	4		
				PHANOGOMPHUS EXILIS	24		

The Pike River is about 70' wide and 3' deep, with slightly sluggish flow. The substrate was diverse, however, with rubble, gravel, sand and silt. However, diversity and abundance were quite low. This river undoubtedly harbors more species than indicated here.

Discussion: No new sites for *Ophiogomphus anomalus* were found, leaving only two verified sites in the state along with possible (but unverified) occurrences on the Minnesota side of the St. Croix River. Most of the rivers that have potential habitat for the species have now been surveyed, at least in part. Although there may still be a small number of undetected locations in the state, the species is obviously quite rare-perhaps Minnesota's rarest dragonfly. Because of this rarity, effort should me made to protect the 2 known sites and the streams and riparian zones of their upstream watersheds. Additional surveys should be conducted on the Vermillion and St. Louis rivers (especially below Interstate 2) in St Louis County, and the Pigeon and Brule rivers in Cook County. These are the most likely waterbodies to harbor populations of the species. This species was recommended for Endangered status after statewide status surveys by Steffens and Smith (1999), and the current surveys study underscore it's rarity.

Dragonfly diversity was low to moderate at most survey sites. The majority of species are widespread in Minnesota, and probably do not have any special conservation needs at this time. One possible exception is *Stylogomphus albistylus*. This species has been verified only from the St Louis River between Highway 100 and Forest Road 130 (Moose Line Rd.). Based on its habitats and distribution in WI and MI, however, it is likely to be found at additional locations if small to medium-sized, rocky streams are surveyed. The species will probably remain secure until further surveys establish its true distribution.

The discovery of dragonfly abnormalities at additional sites, and especially the South Kawishiwi River site where the occurrence rate exceeded 4 percent in a very large sample, indicates that the problem is probably a "regional" one rather than point source pollution. Similar rates of abnormalities are not known from Wisconsin, however, where 40-50,000 or more dragonfly exuviae have been examined over the past decade (William Smith, unpublished). While there are no published data on background levels of abnormalities in dragonfly larvae, personal experience and an informal poll of colleagues indicates that less than 1-2% deformities is probably "normal".

Many of the abnormalities that have been discovered over the past 3 years are in the Genus *Ophiogomphus*. *Ophiogomphus* dragonflies are generally found only in high quality waters and are very habitat-specific; as such, they could be more predisposed to problems than other genera because of their narrow range of tolerance. *O. rupinsulensis* is the most tolerant member of the genus, and numerous abnormalities have been found in this species in northern Minnesota.

Other aquatic invertebrates, such as midges (Diptera: Chironomidae) should be checked for developmental abnormalities. If toxins are affecting dragonfly development, they are present in other levels of the food chain. Midges are a common food source for dragonfly larvae, and the effects of toxins on midge abnormalities have been studied (Warwick 1985).

The abundant and diverse wetlands of the Superior National Forest remain undersurveyed for most dragonflies. The larger warmwater rivers-St Louis, Vermillion, Pigeon and Brule, still need either additional surveys and/or monitoring. This should include both early season surveys for *Ophiogomphus* and other early emergers, and mid-summer surveys for later species such as *Stylurus*. Smaller streams, warm and cold, have yet to be sampled at all. Rare species such as *Somatochlora ensigera*, known from only 3 counties, and others such as *Cordulegaster obliqua* may be found on small streams in the north. The numerous lakes may harbor rare species such as *Somatochlora cingulata*, which has been found at only two locations in the state, both on the Superior National Forest. The many bogs may harbor new state records such as *Williamsonia lintneri, W. fletcheri*, *Somatochlora incurvata*, or other rare species such as *Aeshna sitchensis*, *A. subarctica*, and others.

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APPENDIX

Table of dragonfly abnormalities

River/Site	Species	Description of abnormality
South Kawishiwi	*Ophiogomphus rupinsulensis*	End hook on palpal lobe is shorter than normal
		Curved epiproct
		Twisted left paraproct
		Left antenna segment 3 is "clubbed"
		Misshapen end hook and palpal lobe
		Misshapen ligula
		Misshapen antenna segment 4
		Lateral spine absent on seg. 7
		Very deformed left palp and end hook
		Right antenna segment 3 misshapen-short, cylindrical
		Curved epiproct with elongated anteapical tubercle
		Right antenna segment 3 very short
		left antenna segment 3 slightly short
Stoney River at HWY 1 Wayside	*O. rupinsulensis*	1 malformed antenna
Vermillion at Buyck	*Hylogomphus adelphus*	Crooked paraprocts
	O. rupinsulensis	Short right paraproct
	" " " "	Left lateral spine #7 absent
Vermillion River 4 miles above Buyck	*Gomphurus vastus*	Short left lateral spine on segment 9
	" " "	Short right lateral spine on segment 9
	O. rupinsulensis	Short dorsal hook segment 9
Vermillion River 4 miles above Buyck (cont)		Slightly misshapen, "wavy" lateral margin of segment 8
		"Clubbed" left antenna
		Extremely stunted right cercus, slightly short right paraproct
		Slightly twisted epiproct-very minor