Abundance and Distribution of the Aquatic Moss, *Scouleria marginata,* in the North Umpqua River, Umpqua National Forest, Oregon

Report to the Interagency Special Status/Sensitive Species Program
FY2005 Inventory & Conservation Planning Project

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Executive Summary
Margined streamside moss (*Scouleria marginata*) is a US Forest Service sensitive species. It is known in the Pacific Northwest from only a few scattered locations although it is more common in California. Three sites of this aquatic moss were known from the North Umpqua River. This study provided a systematic inventory of the river between approximately Rock Creek and Soda Springs Dam for this species. Nine new sites of margined streamside moss were found. It is estimated to occur along 29% of the river within the study area. It is replaced upstream from approximately Dog Creek by the similar appearing aquatic moss (*S. aquatica*). Recreation activities do not appear to be significantly impacting margined streamside moss. The impact of the hydroelectric project is more difficult to ascertain, particularly since margined streamside moss was not found in the stretch of the river most affected by the dams.

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Introduction

Scouleria marginata is endemic to western North America. It appears to be most abundant in California but has been reported to occur in Oregon, Washington, Idaho, and British Columbia. In Oregon it was known from Clackamas County in northern Oregon and about five sites in southern Oregon. In addition to the three previously known sites on the North Umpqua River, there is a reported site on Cow Creek, a tributary of the South Umpqua River, and on the Rogue River near Prospect.

There are two species of *Scouleria* that occur in North America. Both species are confined to western North America with *S. aquatica* largely replacing *S. marginata* north of California. The two species have apparently identical habitat and substrate affinities where they co-occur. *Scouleria aquatica* is present throughout the Umpqua basin in streams of all sizes in all but subalpine elevations. The two species are separated taxonomically by the presence of highly thickened margins and lack of peristome teeth in *S. marginata* (Lawton 1971). These species are very difficult to reliably distinguish in the field. Under high magnification ($\geq$ 20x) in good light, the thickened leaf margins of *S. marginata* can be seen. However, *S. aquatica* often produces a bistratose margin that can be mistaken for *S. marginata* in the field.

Scouleria marginata grows in black tufts on bedrock and boulders along rivers. It is continually submersed during the winter but resides above the waterline during summer low flows. The new growth is generally dark green while older leaves are black-brown. The lower portion of the wiry stems is often stripped of leaves that are lost during turbulent winter flows. The thick costa of the stem has both dorsal and ventral stereid bands so commonly the costa, and occasionally the margins, remain attached to the stem after the rest of the leave is lost. Rhizoids sometimes occur along the lower costa.

Aquatic bryophytes are a too often overlooked component of aquatic ecosystems. Bryophytes can be a more significant source of primary productivity than algae (Stream Bryophyte Group 1999, Steinman and Boston 1993), particularly in lower order streams where bryophytes such as *Chilosyphus polyanthos* and *Fontinalis antipyretica* can achieve very high biomass. Bryophytes are an important substrate for periphyton including epiphytic algae and invertebrates. They also trap and retain sediment and detritus that would otherwise be washed downstream. In fact, the otherwise black clumps of *S. marginata* are commonly observed to be coated with a light-colored rime of diatoms and fine sediment when dry.

There were three, widely spaced occurrences of *S. marginata* known from the North Umpqua River. The objective of this study was to evaluate the distribution and abundance of *S. marginata* along this stretch of the river. A secondary objective was to evaluate the threats to the population.

Study Area

The North Umpqua River Basin covers approximately 1,350 m^2 in southwest Oregon. Its headwaters form at Maidu Lake at 5980 ft near the crest of Cascade Mountains in the Mt.

Thielsen Wilderness Area. It joins the South Umpqua River just east of the town of Roseburg and flows in the Pacific Ocean near the town of Reedsport. This study evaluated the aquatic bryophyte communities on the North Umpqua River between the confluence with Rock Creek to the Soda Springs Dam (river mile 35.7 to 69.7). Rock Creek is approximately seven air miles west of the Umpqua National Forest boundary. Elevations within the study area range between 800 to 1640 ft (Table 1).

The channel gradients within the study area are predominantly less than 1 percent. Large boulders and bedrock outcrops and ledges are abundant throughout this stretch of the river. There are also frequent deep trench and dam pools and irregularly spaced cobble and gravel bars (USDA Forest Service and USDI Bureau of Land Management 1999).

Most of the study area is within the designated Wild and Scenic reach of the river. State Highway 138 follows the entire length of the river within the study area. The highway follows the north bank of the river until Marsters Bridge, whereupon the road follows the south bank for the final approximately four miles of the study area. Road fill from the highway extends to the water's edge in numerous areas.

Upstream from the study area is the North Umpqua hydroelectric project operated by PacificCorp. This project includes three major reservoirs (Soda Springs, Toketee, and Lemolo) and eight hydroelectric developments that typically include smaller dams. The project also includes 21.7 miles of canals, 9.8 miles of flumes, and 5.8 miles of penstocks and tunnels. The project was constructed between 1947 and 1958.

There are numerous recreation developments along the river including campgrounds, boat launches, day-use areas, and the Steamboat Inn restaurant and lodge. The North Umpqua is a popular fishing river, particularly for steelhead trout, but the river also supports Coho salmon, Chinook salmon, rainbow trout, cutthroat trout and Pacific lamprey. Rafting and kayaking have also increased in popularity over the last couple of decades.

Methods

The North Umpqua River was sampled at all locations where a vertical section line intersects the river between approximately Rock Creek and the Soda Springs dam. Ten meter long transects were established at the designated areas. Collections were made of all saxicolous (growing on rock) bryophytes below the normal high water mark. Collections were made of all clumps of *Scouleria* spp. occurring at least 1 m apart (up to 11 collections per transect). Only a single collection from each additional species was made. Sampling was done in mid to late summer when low flows leave *Scouleria* spp. above the water line.

Plots were located on the side of the river with major road access. This was initially intended to allow for comparison to plots to be located in recreation areas. However, it was determined during sampling that recreation areas tended to be placed in areas that had relatively little substrate for *Scouleria* spp. Therefore, since comparison to the

recreation areas may have erroneously suggested that recreation use is negatively impacting populations, this element of the study design was discontinued. In some cases, collections were made of *Scouleria* spp. outside of the plot if none was encountered within the transect. These data were used only to evaluate the distribution of the two species within the river corridor and were not included with the plot data.

Table 1. Locations of plots along the North Umpqua River.

Plot No.	Location	UTM X	UTM Y	Elev. (ft)	Owner
3	R. Baker Park	502,411	4,795,693	800	BLM/pvt
4	trailer park	503,978	4,794,075	840	BLM/pvt
5	Smith Springs	505,545	4,793,512	880	BLM/pvt
6	Susan CG trailer park	507,137	4,793,495	880	BLM/pvt
7	Susan Ck CG	508,747	4,793,400	920	BLM/pvt
8	Forest Boundary	510,367	4,793,893	920	USFS
9	Rooster Tail Rapid	511,893	4,794,628	960	USFS
10	Fall Ck Falls	513,526	4,795,334	1000	USFS
11	Raspberry Ck	515,124	4,796,332	1000	USFS
12	E of Bogus Ck	516,703	4,796,774	1040	USFS
13	W of Williams Ck	518,318	4,798,052	1040	USFS
14	E of Alder Ck	519,946	4,798,830	1080	USFS
15	Steamboat	521,435	4,798,956	1120	USFS
16	E of Island CG	523,020	4,798,004	1160	USFS
17	E of Redman Ck	524,659	4,796,847	1200	USFS
18	Apple Creek	526,275	4,794,526	1280	USFS
19	E of Eiffel Tower Rapid	527,896	4,793,887	1280	USFS
20	Dog Ck	529,499	4,793,682	1320	USFS
21	Panther Leap	531,109	4,793,212	1400	USFS
22	Charcoal Point	532,712	4,792,820	1480	USFS
23	W of Marsters Bridge	534,340	4,792,621	1520	USFS
24	Eagle Rock CG	535,937	4,793,447	1560	USFS
25	Old Man Rock	537,559	4,793,369	1600	USFS
26	Pine Bench	539,162	4,794,628	1640	USFS

Results

A total of seven of the 24 plots contained *Scouleria marginata* (Table 2). Two additional new sites were found nearby, but outside of, plots where *S. marginata* was not found. These new sites are distributed across approximately 23-25 miles of the North Umpqua River (Figure 1). All but one of these sites are within the previously known distribution within the river corridor. No occurrences were recorded on any of the BLM plots, however, one site was found outside of the westernmost plot and there was a previously recorded occurrence about two miles downstream of the study area. Four of the seven sites of *S. marginata* occurred in consecutive plots on the western edge of the Umpqua National Forest boundary. If an off-plot occurrence is included, it occurs on or near six of the first seven plots on the Forest although no more than three *S. marginata* collections were made at any of these plots (Table 3). Conversely, only two of the next six plots upstream contained *S. marginata* but these plots had seven and ten collections respectively on them. No sites were found in the westernmost six plots above Dog

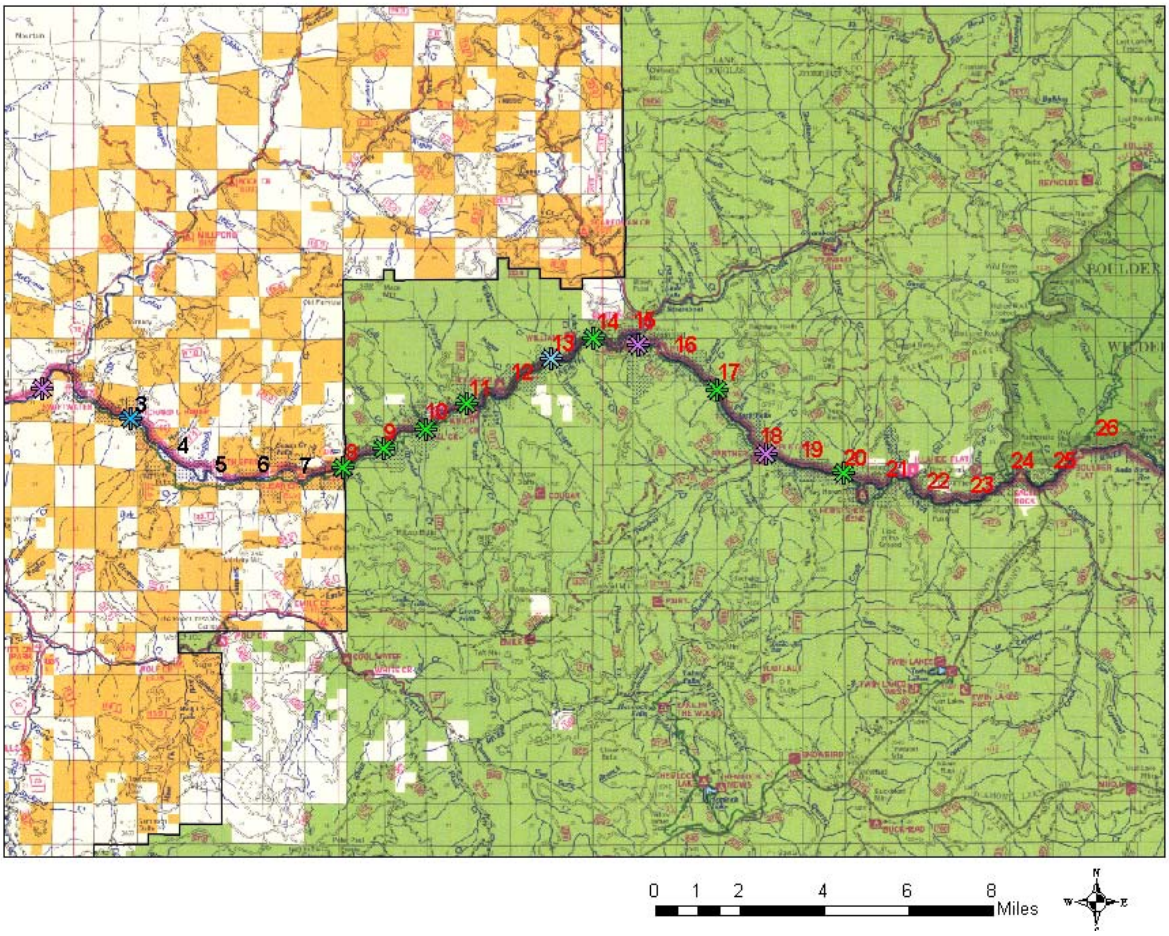

Figure 1. Map of the study area showing the plot distribution and sites of *Scouleria marginata*. Previously known sites are purple; new sites found near, but outside of, plots are blue; and new sites within plots are green. On the background map, green is US Forest Service; gold is BLM, and white is private lands.

Creek although *S. aquatica* was found in four of these six plots. The highest recorded site of *S. marginata* occurred at 1,320 ft.

In addition to the two species of *Scouleria*, 14 mosses and six liverworts were identified as occurring within the transects (Table 2). Most of these species (11 of 20) occurred on only a single plot. *Scleropodium obtusifolium* was by far the most common species. It occurred in every plot. *Orthotrichum rivulare* and *Schistidium rivulare* were the only other species to occur more frequently than either of the *Scouleria* spp. They each occurred in 45.8% of the transects. No species demonstrated close affinity with distribution of *S. marginata*. *Scouleria aquatica* was more likely to occur in the absence of *S. marginata* than with it. Of species with six or more occurrences, only *O. rivulare* and *Schistidium rivulare* co-occurred on more than half of the plots with *Scouleria marginata* (discounting *Scleropodium obtusifolium*, which occurred on all plots). They were each present on slightly more than half the *Scouleria marginata* plots (57.1%). This relationship represents a slight increase above their occurrence on all plots (45.8%).

Table 2. Saxicolous bryophytes encountered within plots. x* = Scouleria marginata was located outside of, but in the vicinity, of the plot. Non-plot occurrences are not included in the totals.

	Plot Number																									
	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**Percent**
Scleropodium obtusifolium	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	24	100.0%
Orthotrichum rivulare		X	X			X		X		X			X	X	X		X	X		X					11	45.8%
Schistidium rivulare		X	X		X	X	X	X	X	X				X	X					X					11	45.8%
Scouleria aquatica		X			X			X	X					X						X		X	X	X	9	37.5%
Racomitrium aciculare											X				X		X	X	X	X	X		X		8	33.3%
Fissidens bryoides	X		X						X	X									X	X			X	X	8	33.3%
Scouleria marginata	x*					X	X	X	X		x*	X			X			X							7	29.2%
Chiloscyphus polyanthos													X	X			X		X				X	X	6	25.0%
Fontinalis antipyretica					X									X					X	X			X	X	6	25.0%
Ceratodon purpureus																	X	X		X					3	12.5%
Brachythecium frigidum			X																					X	2	8.3%
Porella roellii														X											1	4.2%
Ptychomitrium gairdneri																	X								1	4.2%
Bryum weigelii	X																								1	4.2%
Philonotis fontana											X														1	4.2%
Racomitrium varium	X																								1	4.2%
Bryum sp				X																					1	4.2%
Scapania undulata v. dentata																			X						1	4.2%
Jungermannia gracillima																			X						1	4.2%
Racomitrium varium																				X					1	4.2%
Plagiochila asplenioides																							X		1	4.2%
Porella cordaeana																								X	1	4.2%
Number of Associated Spp.	4	4	5	2	4	3	2	4	4	4	3	1	3	7	4	1	6	4	7	9	2	2	7	7		

Table 3. Abundance of *Scouleria* species.

	3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**Total**	**Average**
Scouleria aquatica		1			1			1	6					1						1		2	2	5	20	2.2
Scouleria marginata						3	2	1	1			2			7			10							26	3.7

Species richness exhibited an inverse trend with *S. marginata* presence. Overall there was an average of 4.13 species per plot (SD = 2.11), not including *S. marginata*. On those plots with *S. marginata*, there was an average of 3.14 (SD = 1.22) associated species; those without had 4.53 species (SD = 2.29). This relationship is narrowly rejected as significant at the 95% CI (p = .0621). Among the most common species, *Racomitrium aciculare* and *Fissidens bryoides* were the species most negatively correlated with *S. marginata* (Table 4). Two of eight occurrences of *R. accicular*e co-occurred with *S. marginata* and one of eight occurrences of *F. bryoides* co-occurred. Occurrence counts (n) for all species were too small to evaluate any statistically significant relationship with *S. marginata*.

Table 4. Association of common bryophytes with *Scouleria marginata* and *S. aquatica*.

	w/ Scouleria marginata	**w/o Scouleria marginata**	**w/ Scouleria aquatica**
Scouleria aquatica	28.6%	41.2%	-
Orthotrichum rivulare	57.1%	63.6%	44.4%
Schistidium rivulare	57.1%	54.5%	66.7%
Racomitrium aciculare	28.6%	75.0%	22.2%
Fissidens bryoides	14.3%	87.5%	44.4%
Chiloscyphus polyanthos	0.0%	100.0%	33.3%
Fontinalis antipyretica	0.0%	100.0%	55.6%

Discussion

Scouleria marginata is one of the most common mosses that occurs within this segment of the North Umpqua River. Approximately 29% of the river bank within the study area is occupied by *S. marginata*. Abundance is highly variable. Although the average number of collections per plot was 3.7, this number is skewed by the two most upstream plots where seven and 10 collections were made respectively. All the other plots had only one to three collections per plot. These data suggest that *S. marginata* may be more evenly distributed in the lower portion of the study area although it may be more abundant where it occurs upstream. Distribution and abundance of appropriate substrate (i.e. large boulders and bedrock shelves that are seasonally flooded) appear to be the principle factor governing population size and distribution of *S. marginata* (Figures 2 and 3).

Scouleria marginata may be a poor competitor with other bryophytes. Species richness was notably lower at plots with *S. marginata* than without and most of the common species exhibited a negative relationship with *S. marginata*. *Scouleria aquatica* was expected to co-occur at most *S. marginata* sites since there is no apparent difference in their substrate or hydrologic requirements. It does however, occur across a much broader range of habitats in Oregon that does *S. marginata*. Whereas *S. marginata* appears to be limited to large, bedrock streams at low elevations, *S. aquatica* occurs in streams of all sizes and at all but the highest elevations. In this study, *S. aquatica* occurred on 28.6% of the plots with *S. marginata* but 41.2% of the plots without. The two plots in which the two species co-occurred had limited abundance of *S. marginata*. In drainages upstream from the study area, *S. aquatica* often forms extensive mats, which were observed only

Figure 2. *Scouleria marginata* habitat along the North Umpqua River near the Forest boundary. *Scleropodium obtusifolium* is the olive-green moss on the elevated areas of this rock shelf. *Scouleria marginata* is the black, partially white-encrusted, moss.

Figure 3. *Scouleria marginata* along the North Umpqua River near the Forest boundary growing in a large mat on the side of a boulder.

in the most upstream plot within the study area. These two species are clearly competing for what appears to be the same niche within the study area.

Scleropodium obtusifolium was ubiquitous throughout the study area. It typically formed extensive mats on the tops of boulders and elevated microsites on rock outcrops and rock shelves. It appears to occupy a less aquatic (during the winter) position than *S. marginata*. *Orthotrichum rivulare* and *Schistidium rivulare* demonstrated a patchy distribution throughout the study area. They generally occupied a band of habitat on the rock above, but overlapping, the *Scouleria* spp. but below, although overlapping, *Scleropodium obtusifolium*. These species were as likely to occur with as without *Scouleria marginata*. Together with *S. aquatica*, these two species would be the most likely to be competitors for the same microsites as *S. marginata*.

Several species that occurred primarily on plots without *S. marginata* are probably indicators of poor habitat conditions for *S. marginata* rather than indicators of excessive competition. *Chiloscyphus polyanthos* and *Fontinalis antipyretica* each occurred in six plots, none of which co-occurred with *S. marginata*. Both of these species tend to occupy more aquatic habitats than *S. marginata*. Both often grow in areas that remain submersed throughout the year, whereas *S. marginata* is always exposed during the summer months. *Fissidens bryoides* occurred on only one of the same plots as *S. marginata*. This species was mostly collected from crevices in boulders where a thin layer of soil had collected and should probably not be considered a truly saxicolous species since its usual habitat is soil banks. It too probably represents poor habitat conditions for *S. marginata*. *Racomitrium aciculare* was only recorded on the higher elevation plots although it does occur downstream of the study area at lower elevations as well. This species is tied to the high humidity of riparian areas but mostly appears to occur above the zone of continuous submersion during winter flows.

It was thought that recreational activities may be a significant threat to *S. marginata*. Campgrounds, boat launch sites, and day-use areas are abundant along the river. Rocks immediately adjacent to boat launches, in particular, were observed to be largely denuded of bryophytes (Figure 4). However, it appears that developed recreation sites tend to be placed along less rocky areas of river where *S. marginata* habitat is sparse. There are exceptions. For instance, the large rock shelf in Figure 2 is adjacent to Richard Baker County Park. This park receives use during the summer by fly fishermen and picnickers but impact to the bryoflora on the rock shelf appears to be minimal and *S. marginata* is abundant.

The effect of the hydroelectric project upstream is difficult to evaluate since there are no records of *S. marginata* (or any bryophytes) along the river prior to its construction between 1947 and 1958. However, current conditions are evidently favorable to *S. marginata*, though not immediately below the dams, and whatever impacts might have occurred have presumably largely stabilized. The effect of some activities remain equivocal, particular that of ramping. The project was originally designed and operated without ramping of flows. Beginning in about the early 1960's, the power company began releasing water during the summer months to increase generating capacity. This

resulted in daily increase in discharge of up to one foot at the Copeland Creek gauging station (near the western portion of the study area). The effect downstream would less as the river widens out. During the late summer months, this would result in regular watering and dewatering of *Scouleria* spp., particularly upstream. Ramping is being limited under the relicensing agreement.

The dams also capture sediment and, under the new license agreement, gravel augmentation below Soda Springs dam was initiated in 2005. Scour has the observed effect upon *Scouleria* spp. of stripping foliage from the stem so it is possible that gravel augmentation could have an impact upon populations, particularly in the upper reaches. However, all of the *S. marginata* currently appears to be well downstream of the dam. In addition, sediment inputs from tributaries below the dam should obviate much of the impact from the upstream augmentation upon the existing population.

Finally, the dams affect other water quality elements including dissolved oxygen, pH, stream temperatures, and algal biomass. These effects are most pronounced immediately below the dams (Anderson and Carpenter 1998). These various alterations to the stream system from the hydroelectric project could be part of the reason why *S. aquatica*, with its broader ecological amplitude, replaces *S. marginata* in the approximately 8-10 mile stretch below Soda Springs dam. It is known that *S. aquatica* replaces *S. marginata* higher up in all the drainages in the basin so it is also possible that *S. marginata* is simply reaching the upper limits of its ecological tolerance for reasons unrelated to the hydropower project. Water quality and fisheries issues were evaluated and addressed during the hydropower relicensing process. However, water quality issues that govern fish or macroinvertabrates may not be the same as those affecting bryophyte populations (Paavola et al. 2003) therefore intended improvement to fisheries may not extend to *S. marginata* and other aquatic bryophytes.

Figure 4. Boulders that have largely been denuded of bryophytes by the Gravel Bin boat launch. The two large boulders on the left were moved to provide river access. There are relatively few large boulders along this stretch.

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