JACK CREEK

Oregon Spotted Frog (*Rana pretiosa*)

SITE MANAGEMENT PLAN

Chemult Ranger District
Fremont-Winema National Forest
USDA Forest Service

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SITE NAME

Jack Creek

TARGET SPECIES

Oregon Spotted Frog (*Rana pretiosa*)

LEGAL DESCRIPTION

Jack Creek is located in the Williamson River watershed in Klamath County, Oregon (Figure 1). The site is a mix of private and Forest service land (Figure 2). The private parcels are: Lower Jamison Meadow, T27S, R9E, Section 24 and T27S, R10E, section 19; Upper Jamison Meadow, T27S, R9E, Section 13; and Moffit meadow, T27S, R9E, Section 2. The Forest Service parcels are: Lower Jamison Meadow, T27S, R10E, Section 19, 20, and 29; Upper Jamison Meadow, T27S, R9E, Sections 13 and 24; Lower Jack, T27S, R9E, Sections 13 and 14; Middle Jack, T27S, R9E, Sections 2, 11 and 12; and Upper Jack T27S, R9E, Section 35.

INTRODUCTION

Site Management Plans (SMPs) provide an overview of conservation challenges and opportunities for sites of specific interest within U.S. Forest Service holdings. They also summarize possible actions that may help to achieve the management goals for that particular site for a species of interest. SMPs are not decision documents, but provide guidance and considerations when dealing with the management of the site. Some potential actions may not be implemented because of the limited availability of funding or personnel, or environmental disclosures through the NEPA process. SMPs incorporate the best science available at the time of writing. However, SMPs should be updated as new scientific information becomes available, and this plan may be changed or modified based on new information in the future.

This particular SMP addresses the reaches of Jack Creek and their associated meadows (Table 1) that support one of the nine known remaining populations of Oregon spotted frogs (*Rana*

pretiosa) within the Klamath Basin, and one of five known *R. pretiosa* populations that may occur at least partly on lands managed by the Fremont-Winema National Forest (Figure 2). The site is a mix of public forest and private ranch lands, which form a checkerboard of ownership throughout the known range of this population of frogs (Figure 2). Much of the riparian area in Jack Creek where *R. pretiosa* occurred historically is within the Antelope Horse and Cattle Grazing Allotment, and has been grazed by livestock for over a century.

Table 1. Reaches of Jack Creek discussed in this SMP. Habitat is defined as Ecological Inventory Units 2000, 2001, 2006 and 2008; see text. Further details regarding ecological characteristics and R. pretiosa *use are discussed in the text. Sources: Markus 2011, Ruda and Hogan 2008. Detailed habitat descriptions can be found in Markus 2011. Length is estimated reach length with potential frog habitat based on EUI classifications.*

Reach	Approx. Length	Habitat (ha) along reach	Ownership
Upper Jack reach	0.9 km	11.7 ha (29 acres)	USFS
Moffit Meadow	1.8 km	28.7 ha (71 acres)	Private
Middle Jack	3.2 km	26.3 ha (65 acres)	USFS
Lower Jack	1.4 km	27.5 ha (68 acres)	USFS
Upper Jamison	1.4 km	19.4 ha (48 acres)	Private
Upper Jamison	0.6 km	7.3 ha in two pieces (18 acres)	USFS
Lower Jamison	2.2 km	20.2 ha in 3 pieces (50 acres)	USFS
Lower Jamison	1.6 km	37.2 ha (92 acres)	Private

Previous versions of this document were reviewed and incorporated as appropriate, as well as other documents on file, published literature, and personal communication with several experts. This SMP should be considered the final draft and supersedes earlier versions that may be on file.

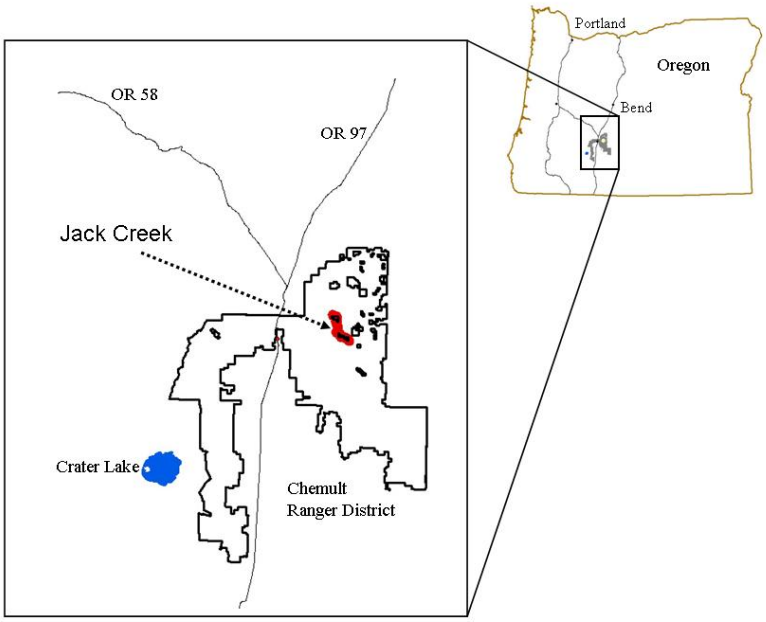

Figure 1. Site vicinity map for Jack Creek in the Chemult Ranger District, Fremont-Winema National Forest in the state of Oregon.

GOAL OF THE MANAGEMENT PLAN

The immediate goal of this SMP for the Jack Creek population of *R. pretiosa* is to create conditions that would allow the frogs to increase in numbers in the Upper Jamison and Lower Jack reaches of the site. A severe population decline of *R. pretiosa* at Jack Creek has occurred during the last decade. Recent surveys indicate that these may be the only reaches that support *R. pretiosa* breeding sites. The time frame of this plan is expected to be 10 years. This time frame allows implementation and completion of a number of potential management actions. After 10 years, it is expected that the success of actions taken thus far, future funding options, and new science and information would be reviewed. The long-term goal is to restore habitat in the upper Middle Jack, Moffit, and Lower Jamison reaches such that *R. pretiosa* can recolonize former habitat throughout the drainage, and possibly expand farther throughout the Jack Creek system. Jack Creek is one of the few sites with extant populations of *R. pretiosa* that lacks bullfrogs, non-native predatory fish, or is under immediate threats from invasive plants such as reed canary grass. These taxa are invasive species that are threatening the long-term persistence

of *R. pretiosa* in other locations. This makes the Jack Creek population of *R. pretiosa* particularly important for the conservation of the species.

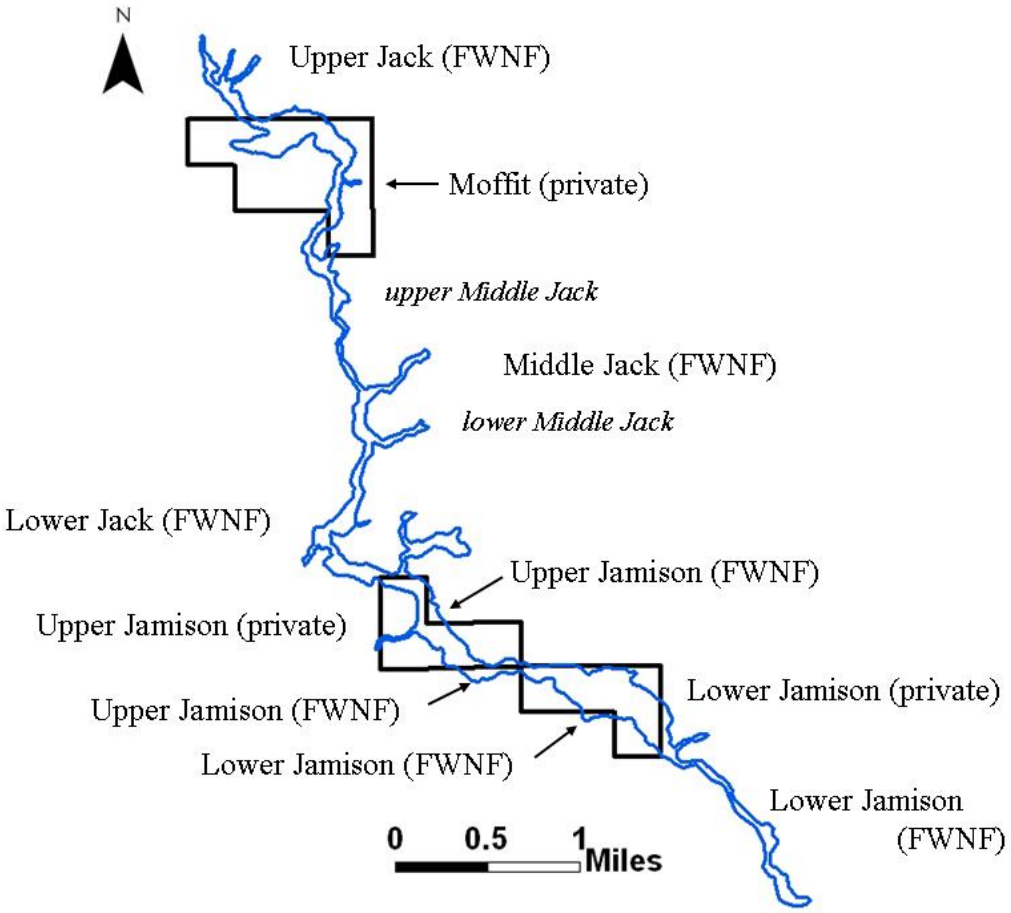

Figure 2. Land ownership of the major reaches occupied by R. Pretiosa *on Jack Creek.*

BACKGROUND

Species Range and Distribution

R. pretiosa have declined to less than 30% of their historical range, which once extended from northern California into southern British Columbia. As of 2007, only 33 localities were known to support *R. pretiosa* populations (Cushman and Pearl 2007, Pearl et al. 2009). A summary of the status of *R. pretiosa* can be found in *A Conservation Assessment for the Oregon Spotted Frog (Rana pretiosa)* (Cushman and Pearl 2007).

The Jack Creek population is one of several in the Klamath Basin which together comprise a genetically distinct cluster (Blouin et al. 2010). The Jack Creek population is somewhat distinct from other populations within the region, although the most recent analysis suggests that the genetic structuring among the Klamath Basin populations is minor enough that they should all be considered members of the same group (Blouin et al. 2010). Low genetic variation is a characteristic of all *R. pretiosa* populations (Funk et al. 2008, Blouin et al. 2010).

R. pretiosa at Jack Creek are approximately 20 river miles from the nearest known neighboring population of *R. pretiosa* on the Williamson River and Klamath Marsh (A. Markus, USFS, personal communication 2011, Figure 3). Water typically flows along the entire length of the system only during spring runoff (A. Markus, USFS, personal communication 2011). Because R. pretiosa does not readily move across dry land, and is unlikely to migrate upstream in the cold, fast-moving waters of snowmelt, immigration of frogs into the Jack Creek system is probably a very rare event; lack of movement among populations separated by greater than 10 km (6 miles) was upheld by genetic analysis (Blouin et al. 2010).

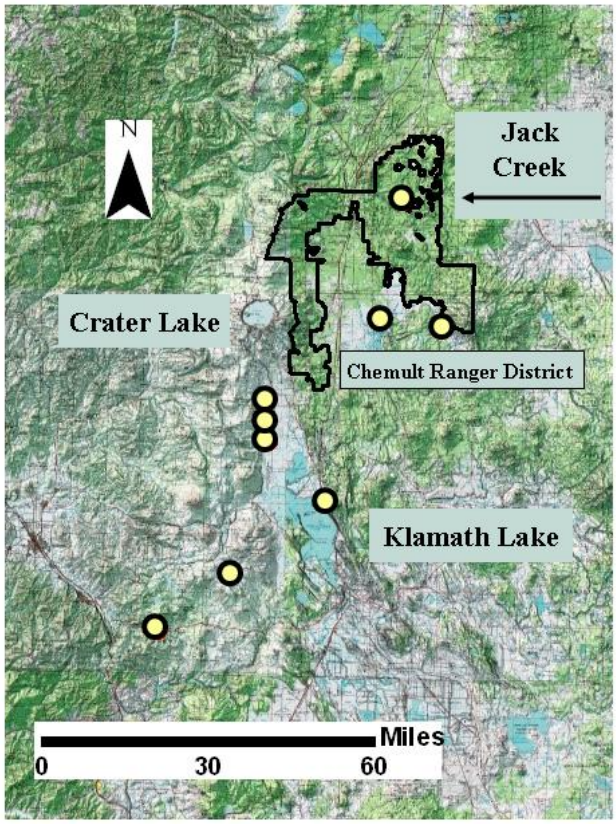

Figure 3. Locations of R. pretiosa *populations in the Klamath Basin.*

Species Life History

A thorough description of the life history of *R. pretiosa* can be found in Cushman and Pearl (2007). Jack Creek is the highest-elevation site known to support *R. pretiosa,* and the local climate may possibly slow the frogs' growth rates and delay maturation into breeding adults (Hayes 1998). *R. pretiosa* in Jack Creek have typically laid eggs between mid-April and mid-May depending on weather conditions (C. A. Pearl, USGS, personal communication 2011). Metamorphosis usually occurs in August and September at this site (Forbes and Peterson 1999, C. A Pearl, USGS, personal communication 2011). Radio-tagged adults moved into overwintering habitat in mid-October (Shovlain 2005). *R. pretiosa* may take an additional year to reach maturity at Jack Creek based on growth rates (M. Hayes, WDFW, personal

communication). Population recovery in this site may therefore require more time than in a lowland site.

Site Description

Jack Creek provides numerous habitat features that are used by *R. pretiosa* as summarized in Cushman and Pearl (2007). Springs, flowing channels, beaver runs, undercut banks, and deep pools offer winter shelter. *R. pretiosa* uses shallow flooded areas along the creek for oviposition. Warmer, slow-moving or still-water pools such as remnant beaver ponds and perennial wetlands provide foraging and basking habitat in summer. Jack Creek *R. pretiosa* habitat is comprised of the terrestrial Ecological Unit Inventory (EUI) map units 2000, 2001, 2006 and 2008; more information regarding specific composition of the EUI unit types and their distribution can be found elsewhere (USDA 2001). Although this SMP does not further discuss the EUI, these data may be useful in determining the location and extent of various restoration activities, particularly those associated with vegetation. Kovalchick's Riparian Plant Associations may be another useful resource. The hydrological processes underlying vegetation patterns identified in the EUI are described below.

The reaches and meadows that make up this section of Jack Creek will be referred to as the following ecological units: Upper Jack, Moffit, upper Middle Jack, lower Middle Jack, Lower Jack, Upper Jamison, and Lower Jamison (Figure 2). For the purposes of this SMP, reports of frog locations are generally limited to those reported in the Forest Services Natural Resource Information System database (NRIS November 2011), although other incidental sightings have been reported for the Jack Creek system and are mentioned where particularly relevant.

The site is a mosaic of private inholdings embedded within the Fremont-Winema National Forest, (FWNF, Figure 2 and Table 1). The very northern end of the site, Upper Jack reach, is within the FWNF. Jack Creek then flows through Moffit meadow, owned by Jim and Helen Schelhaas and managed by Iverson Ranch. It then re-enters FWNF land at the north end of Middle Jack reach and continues downstream on FWNF lands through the Lower Jack reach. Upper Jamison and Lower Jamison meadows are a mix of private and FWNF ownership, with the bulk of the meadow owned by Iverson Ranch. The uplands around the creek are primarily within the boundaries of the FWNF.

The reaches are described here in more detail from north to south. Upper Jack reach offers a total of 11.7 ha (29 acres) of potential habitat based on EUI map unit classifications 2000, 2001, 2006 and 2008. Upper Jack provides potential overwintering habitat, with more limited breeding habitat. Historical beaver activity created dams that are now defunct, and the last sighting of beaver in the Jack Creek system was detected here in 2000. This animal did not appear to remain in the system (Markus 2011, A. Markus, USFS, personal communication 2011). There are no records of frogs in Upper Jack reach in the NRIS database (Figure 4), although they may have occurred in this reach when beaver dams created habitat.

Moffit Meadow is immediately south of Upper Jack and contains 28.7 ha (71 acres) of potential breeding and summer habitat although no frogs or egg masses have been documented since 2005 (NRIS November 2011). Survey effort has been sporadic at best since 2003. There appears to have been a loss of open water, off-channel habitat although the ecological processes behind this loss are not understood (C. A. Pearl, USGS, personal communication). Vegetative succession may be one factor (S. Malaby, USFS, personal communication 2011).

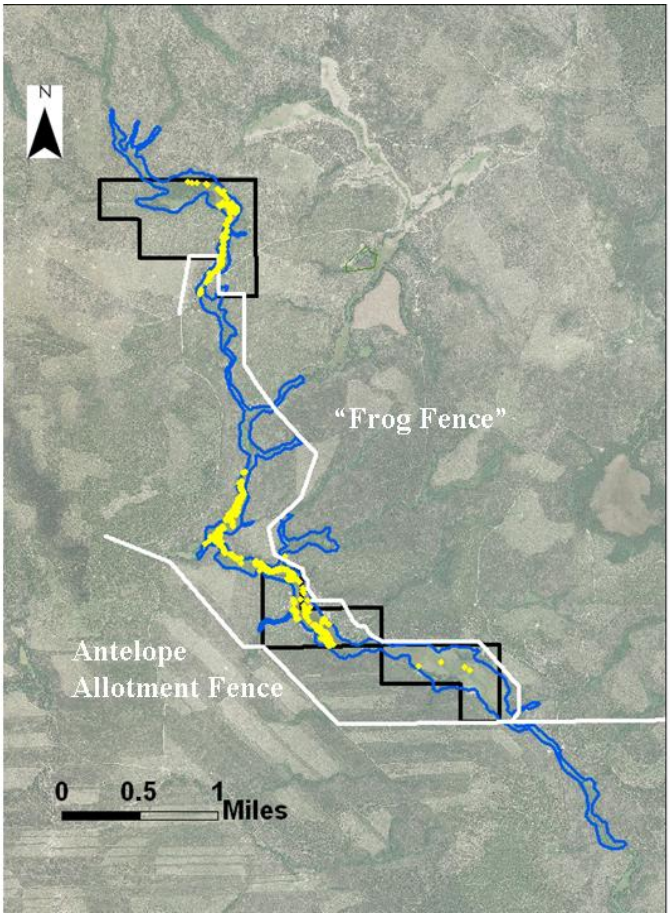

Figure 4. Locations of R. pretiosa *individuals and egg masses recorded in the NRIS database are indicated in yellow, frog habitat based on EUI classifications is indicated in blue. Private lands are outlined in black.*

The Middle Jack reach contains 26.3 ha (65 acres) of potential breeding and tadpole habitat for *R. pretiosa* (Markus 2011). Middle Jack can be broken into two subsections based on habitat. The upper portion is an extension of the conditions found in Moffit meadow immediately to the north and contains historical breeding locations. The lower section is generally much less suitable *R. pretiosa* habitat based on stream velocity, narrower meadow width, presence of lodgepole pine, and more limited off-channel water. This section of reach is characterized by more rapid water flow and more lodgepole pine than other sections of the creek. The creek does not form extensive wetlands in this section, although in-stream pools and springs are common. No breeding by *R. pretiosa* has been documented along much of the reach (Figure 4), although it has not been included in egg mass surveys because breeding habitat appears to be limited or

absent below the end of Moffit meadow under present conditions (C. A. Pearl, USGS, personal communication 2011).

The Lower Jack meadow harbors some of the last known spotted frogs in the system. It comprises 27.5 ha (68 acres) of habitat that includes elements needed for all life stages. The frogs are concentrated at the upper end of the Lower Jack reach, whereas the lower section is predominately a willow wetland that offers more limited breeding or summer habitat (C. A. Pearl, USGS, personal communication 2011).

The Upper Jamison meadow also harbors the last breeding spotted frogs in the system documented in NRIS. There are approximately 7.3 ha (18 acres) on FWNF and 19.4 ha (48 acres) in the private holding of Iverson Ranch (Figure 2). *R. pretiosa* breeding in the last several years has been found mainly on Iverson Ranch's parcel, although adult frogs have been found on both FWNF and Iverson Ranch lands over those same years (Markus 2011, C. A. Pearl, USGS, personal communication 2011). Specific overwintering sites are not known, but Upper Jamison Meadow appears to provide habitat for all seasonal uses.

The lowest reach used by frogs as per the NRIS database is Lower Jamison meadow (Figure 4). There are approximately 20.2 ha (50 acres) on FWNF and 37.2 ha (92 acres) in the private holding of Iverson Ranch (Figure 2). Frogs of any life stage have not been recorded in NRIS since 2003. Post-metamorphic frogs and breeding have been documented in Lower Jamison historically. This 38-ha (96-acre) meadow currently has limited breeding habitat, but off-channel pools during late summer are limited and no known wintering habitat occurs on this meadow (C. A. Pearl, USGS, personal communication 2011, Markus 2011). There have been reports of sightings of *R. pretiosa* below Lower Jamison on Forest lands, but these have not been recorded in the NRIS database as of November 2011. They indicate the possibility that more frogs may occur in the system than currently recognized.

The Lower Jamison reach of Jack Creek is intermittent, and seems unlikely to contain much suitable habitat during dry years. It is unknown at this time whether the frogs seen below Lower

Jamison move upstream during dry years, thus relying on habitat connectivity along the creek through the private lands to reach adequate water.

Level II stream surveys of the Forest Service portions of Jack Creek were conducted in August 2003. These surveys found that stream banks were 98-100% stable, and little to no grazing impacts were observed (Ruda and Hogan 2008). These data were collected during the time when season-long grazing occurred on Jack Creek. Although some impacts including the head cut on Lower Jack and heavily grazed willows on Moffit and Lower Jamison have been noted, habitat degradation appears to be limited to isolated locations. Habitat assessments on Iverson lands have been limited, however.

Jack Creek Abundance and Trends

Ranid frogs in upper Jack Creek were first reported in 1978 although they were misidentified as red-legged frogs at that time. The species' identity was confirmed in 1996 (Hayes 1998). Surveys conducted since then revealed that there were generally two clusters of frog sightings, one in Moffit and upper Middle Jack, the other in Lower Jack and Upper Jamison (Forbes and Peterson 1999, Figure 2). Three marked frogs covered distances of 1-3 km (0.6 – 1.9 miles) from the site of capture, suggesting that there was potential for genetic interchange among the occupied reaches although most marked frogs were not detected moving beyond the immediate area of their initial capture (Forbes and Peterson 1999).

Frogs have not been reported on Moffit and upper Middle Jack since 2005 in the NRIS database. Surveys in these reaches have been sporadic at best. No breeding has been documented in Lower Jamison since 2003. Egg mass surveys have shown sharp declines in breeding attempts throughout Jack Creek since 2000, with roughly 300 egg masses or more found each year prior to that date. In 2001, 167 egg masses were found, but surveys conducted since 2006 have found fewer than two dozen egg masses (Chemult Ranger District file data, Fremont-Winema National Forest). Although surveys were discontinued along some reaches in this time period, ongoing surveys of areas that once supported large numbers of egg masses have noted sharp declines through 2008, with very few egg masses found in more recent years.

Drought within the Klamath Basin coincided roughly with the reduction of *R. pretiosa* populations in Jack Creek. Loss of open-water habitat may have concentrated frogs in small stretches of creek channel and isolated open pools, allowing easier access for predators and increasing competition for food and basking sites. In addition, cattle grazing the allotment would be more likely in drought years to use the same areas as the frogs, leading to potential negative interactions through direct effects such as trampling and indirect effects such as reduction of cover and reduced water quality.

Cattle have not grazed Middle Jack, Lower Jack, or Upper Jamison since 2008 in response to the decline in *R. pretiosa* population size, but numbers of breeding frogs apparently have not increased. Although frogs metamorphose from larvae at the end of their first summer, it may take an additional three years for them to reach sexual maturity at this site (M. Hayes, WDFW, personal communication). Surveys for juvenile and adult frogs may detect changes in population numbers and structure more quickly than egg mass surveys. Unfortunately, only egg-mass data are available.

Apparent loss of open water habitat throughout the system has been noted by Forest Service personnel and spotted frog researchers, although specific mechanisms behind this loss have not been identified (C. A. Pearl, USGS, personal communication 2011). Changes in habitat may be related to the natural process of vegetative succession within the riparian system (S. Malaby, USFS, personal communication 2011). Other factors that may be operating in different reaches include head cuts and incised stream beds, causing loss of water table connectivity, and failure of most of the remaining remnants of old beaver dams to hold back water. Much of the frogs' breeding activity in Lower Jack reach has been associated with beaver dam remnants (C. A. Pearl, USGS, personal communication 2011).

Ecological Processes

Hydrology

One of the most important processes shaping *R. pretiosa* habitat along Jack Creek is the watershed's hydrology. The hydrology is substantially influenced by the underlying geology, which reflects the area's volcanic past. The site is a complex layering of sedimentary rock

interspersed with pyroclastic and hydroclastic deposits (Cummings 2007). The groundwater in this area is perched above the regional water table, which may not be connected hydrologically to the Williamson River drainage (M. Cummings, Portland State University, personal communication 2011). Groundwater flow to the surface is influenced by the occurrence of impermeable rock layers in the Jack Creek system. Although there are well-defined springs, more commonly surface expression is in the form of broad seeps that form both perennial and temporary wetlands (Cummings 2007).

Pumice also affects surface-water expression. A thick layer of pumice lies under Jack Creek's meadows, and this layer retains water throughout the summer drought. Water levels in the pumice layer may drop by 3 to 5 feet over the summer although the bottom portion remains wet. The layer is recharged by snowmelt runoff. The pumice layer can provide a slow, sustained release of water during dry periods although the magnitude and duration of this effect is unknown. Dry pumice may shift within the water column in the soil profile (M. Cummings, Portland State University, personal communication 2011). This instability may lead to intrusion of pumice into dug wells or pits in this region (K. Little, Iverson Ranch, personal communication 2011). Research into the hydrology of Jack Creek is ongoing (M. Cummings, Portland State University, personal communication 2011).

Site hydrology may also be influenced by lodgepole pine encroachment onto the wet meadows (Knight et al. 1985, Burton 1997). Historically, encroachment would have been slowed or reversed by fire and the activity of beaver.

Disturbance

Spotted frogs use sites with early seral vegetation (Hayes 1998). Historically, disturbance regimes that favored maintenance of open water and early seral-stage vegetative structure included fire and the activities of beaver. Cattle grazing may have helped maintain suitable vegetative structure in the absence of beaver and fire (Hayes 1998).

Beaver dams help hold back peak flows and maintain water flows later in the season. These ponds are associated with increased water temperatures (Rosell et al. 2005), which appear to be favored by *R. pretiosa*. Beaver also set back vegetative succession and create light gaps in

riparian vegetation (Rosell et al. 2005), which may also increase water temperatures. Beaver have been absent from the Jack Creek system for many years, although a few remnant dams are providing frog habitat (C. A. Pearl, USGS, personal communication 2011). Beaver may be particularly crucial as climate change alters regional precipitation and temperature patterns because of their ability to create open water even in drought (Hood and Bayley 2008).

Fire has not occurred on a large scale in the watershed for over a century although numerous small fires have occurred, primarily as a result of human activity (Brown et al. 2004). Historically, fire in this system may have burned even the meadows at a low intensity fairly frequently (Brown et al. 2004). Fire may therefore have helped maintain the early-stage, open, low-stature vegetative structure favored by *R. pretiosa*. It may also have helped prevent lodgepole pine encroachment onto the meadows, which may affect hydrology and shade out riparian species such as willow and alder (Brown et al. 2004). The historical fire regime for this region is unknown (G. Riegel, USFS, personal communication 2011).

Site Management History and Current Land Allocations

Grazing history

Jack Creek has been grazed for over a century although livestock species and stocking rates have varied. Until 2003, the Upper and Lower Jamison meadows were grazed under a special use grazing permit. In 2003, the management of the Jack Creek reaches was shifted to the terms and conditions of the Antelope Allotment 10-year permit, which allowed 419 cow/calf pairs to graze the allotment on FWNF lands. An additional 75 cow/calf pairs have grazed on the private lands. In 2008, the grazing permit was modified so that grazing was discontinued on occupied *R. pretiosa* habitat, encompassing National Forest System lands from Middle Jack downstream through the Lower Jamison. Fences were built south of the Moffit inholding and to the east of Jack Creek along these reaches south to the junction of Lower Jack and Upper Jamison. This second fence is the so-called “frog fence” (Figure 4). Some grazing was conducted on the Iverson Ranch portion of Lower Jamison and Moffit in 2010-2011, but no grazing has occurred on Iverson Ranch lands in Upper Jamison meadows since 2008. Currently, there is a partial wire fence between Upper Jamison and Lower Jamison, supplemented with an electric fence to keep

cattle restricted to the Lower Jamison meadow. Neither type of fence has been entirely effective in keeping cattle out of the occupied habitat in Upper Jamison.

Season-long grazing has continued through 2011 on Moffit and Lower Jamison. Prior to 2008, season-long grazing had been conducted throughout *R. pretiosa* habitat on Jack Creek within the Antelope Allotment. Because of past land use and the nature of interspersed land ownership on Jack Creek, potential management actions have also been developed for cooperative management between Iverson Ranch and the Forest Service. These can be found in Appendix B. These actions provide one possible option for grazing management that could be considered through the NEPA process.

Land Allocations

FWNF land allocations in this site are comprised primarily of Management Area 8 (Riparian Areas) surrounded by Management Area 12 (Timber Production) according to the Winema Land and Resource Management Plan (1990).

Past restoration efforts

A number of restoration projects have been undertaken on Iverson lands. Iverson Ranch has thinned lodgepole pine adjacent to the Upper and Lower Jamison meadows. Fences were built around three large, deep off-channel springs that may provide overwintering habitat for *R. pretiosa* in Upper Jamison. In addition, two off-meadow watering tanks have been installed for use by cows, one each adjacent to Lower Jamison and Upper Jamison meadows. The tanks are filled from water pumped from springs adjacent to the meadow edge. Iverson Ranch undertook these management actions in collaboration with support from the Klamath Basin Rangeland Trust and U.S. Fish and Wildlife Service in 2009-2010 as the first phase of a two-phase restoration effort. The second phase will consist of thinning lodgepole and installing an off-meadow watering tank on Moffit meadow in the fall of 2011 into 2012. In addition, straw wattles were placed in Upper Jamison meadow in an attempt to slow water flow and maintain standing water in breeding areas in 2009. This was undertaken with consultation and assistance from U.S. Fish and Wildlife Service.

Projects undertaken to improve *R. pretiosa* habitat within the Fremont-Winema National Forest have included extensive lodgepole thinning and removal along meadow edges (2009 to the present). An unsuccessful attempt to fix the head cuts on Lower Jack using rock placed in the head cut occurred in 1998 (A. Markus, USFS, personal communication 2011). Four shallow ponds, based on the design used at Dilman Meadows (Chelgren et al. 2008) will be installed on the Lower Jack reach along with willow replanting and repair of cattle trails. These ponds may be created as early as November 2011.

Site Threats

Potential threats to *R. pretiosa* across their range have been catalogued by Cushman and Pearl (2007). Only those threats that are present or possible in the Jack Creek system are discussed here.

Loss and alteration of habitat

This is likely the greatest single threat to the persistence of *R. pretiosa* within the Jack Creek system. Open-water habitat appears to be declining at least in part because of a lack of historical disturbance regimes, particularly beaver activity, that interrupt plant community succession and maintain this vital habitat feature. Changes may have been exacerbated by the years of drought as repeated low-water years and absence of disturbance have had the potential to reduce available off-channel habitat for all *R. pretiosa* life stages. In the near term, recovery efforts are likely best concentrated on enhancing habitat quality in reaches currently occupied by *R. pretiosa*.

Jack Creek is a low-gradient stream, in which scour events rarely occur. Over time, deposition of sediment may cause pools and channels to fill, causing a loss of deep water habitat. It is not clear how the system renews or maintains variable water depths (Hayes 1998), although loss of shallow pool habitat associated with growth of sedge has been noted (C. A. Pearl, USGS, personal communication, Hayes 1998).

Vegetative changes that may reduce the quality of *R. pretiosa* habitat in the Jack Creek system also include conifer encroachment, which can lead to shading of shallow-water habitats at the meadow edges that are needed for breeding and larval development.

Invasive species

Invasion of wetlands by plant species such as reed canary grass (*Phalaris arundinacea*) and other exotic species reduces habitat quality for *R. pretiosa* by increasing vegetation density (Watson et al. 2003). Fortunately, Jack Creek is free of most invasive plant species, although small patches of reed canary grass and Canada thistle (*Cirsium arvense*) are present and could spread rapidly if not removed. The reed canary grass and Canada thistle are associated with the head-cut repair on Lower Jack reach. Bullfrogs and non-native fish are not present in the site currently.

Despite a century of livestock grazing, cattle and sheep have not brought in many of the problem weeds commonly found in the region. However, overgrazing in particular may lead to the creation of conditions favorable to invasive weed establishment.

Livestock grazing

Grazing by cattle and other livestock can alter the structure of vegetation in frog habitat, but the effects of grazing on *R. pretiosa* are complex (McAllister and Leonard 1997). *R. pretiosa* use submerged, slightly sloping benches as oviposition sites, laying their eggs above the previous year's matted vegetation. Too much standing vegetation may reduce water temperatures in these shallow areas (McAllister and White 2001). Summer habitat consists of shallow flooded areas with moderate emergent vegetation, and open water without dense emergent vegetation (Hayes 1998). Negative effects of too much vegetation have been observed in systems with very dense invasive vegetation such as reed canary grass (Cushman and Pearl 2007). Overall, it appears that *R. pretiosa* selects moderate vegetation densities.

Adult *R. pretiosa* moved away from grazed areas into ungrazed enclosures on Jack Creek, apparently as grazing pressure increased and vegetative cover decreased somewhat (Shovlain 2005). Whether this movement may have been because of habitat alteration or the disturbance caused by the cattle themselves was unclear.

In 1997, Hayes (1998) noted that *R. pretiosa* were less commonly found inside cattle exclosures than outside of them, where sedges in particular had been reduced through grazing. The presence or absence of grazing alone at a site was not useful as a predictor of number of *R. pretiosa* egg masses laid (Pearl et al. 2009). Watson and coworkers (Watson et al. 2003) noted that *R. pretiosa* locations in Dempsey Creek, Washington, were associated with reduced cover of emergent vegetation in shallow water, which was associated with grazing. These mixed results suggest the role of grazing on *R. pretiosa* habitat use is complex and dependent upon site characteristics.

Additional studies on the effects of grazing have been conducted on the related Columbia spotted frog (*Rana luteiventris*). These frogs did not show short-term responses to grazing exclosures in a replicated field experiment in eastern Oregon (Adams et al. 2009), and no effects on oviposition, larval survival, or size at metamorphosis were found despite significant reductions in vegetation height associated with grazing. An earlier, non-manipulative study of Columbia spotted frogs at sites with and without grazing also found no effects on reproduction (Bull and Hayes 2000). *R. pretiosa* may differ in their behavior from *R. luteiventris*, however, and site conditions that may have interacted with grazing to either worsen or buffer its effects are not well understood.

Cattle may pose a direct threat to *R. pretiosa* survival through trampling, although the magnitude of this threat is unknown. *R. pretiosa* behavioral responses to disturbance include diving to the bottom of a water body and hiding in the substrate (Licht 1986). When water levels are low, cattle may concentrate at pools or reaches occupied by *R. pretiosa* and the risks of trampling likely increase. This risk is likely greatly enhanced during drought years, when off-channel water is limited or not available. Frogs may also be at greater risk in August and early September, when tadpoles are transforming into young frogs and have compromised ability to escape danger.

Grazing may also affect vegetative structure and species composition if cattle introduce exotic weed seeds in their manure or transport seeds externally on their hides. Overgrazing may

provide conditions for invasive plant establishment. Conversely, cattle grazing may also keep invasive plants in check, which then could spread after grazing is discontinued.

Degraded water quality

Reduced water quality resulting from grazing is a potential threat to *R. pretiosa* at Jack Creek. Amphibians in general and *R. pretiosa* in particular are known to be quite sensitive to low concentrations of nitrates and other pollutants (Boyer and Grue 1995, Marco et al. 1999). Water quality monitoring data from Jack Creek have generally not detected nitrates at levels of concern (R. C. Ford, USFS, personal communication 2011 and unpublished data), although higher concentrations may occur for short time periods. Late-summer levels of nitrate, nitrite, orthophosphate, and ammonia were not found to be elevated in ponds surrounded by cattle grazing elsewhere (Adams et al. 2009). Other researchers have documented reduced water quality and larval amphibian species richness and abundance in ponds in grazed pastures in Tennessee, however (Schmutzer et al. 2008). Groundwater contributions to surface water volume and surface flow may alter exposure concentrations experienced by aquatic organisms, and the cumulative effects of these factors is unknown. Although fecal coliform levels may increase substantially during grazing, effects of coliform on amphibians are unknown. Beaver ponds may also have high fecal coliform counts, presumably from the presence of the beaver themselves (R. C. Ford, USFS, personal communication 2011). High nitrate and nitrite levels are probably more likely to be of concern than fecal coliform counts.

Work performed in the Netherlands found that nitrate from urine, not manure, had the potential to leach into ground waters, although grazing intensity, vegetative uptake of nitrate, weather, groundwater levels, and soil conditions affected the leaching process (Hack-Ten-Broeke et al. 1996). It appears that excrement from cattle may lead to nitrite levels that are associated with negative effects on *R. pretiosa* under some circumstances. The fact that frogs have persisted in the system despite a century of livestock grazing suggests that nitrate and nitrite levels in the creek do not often reach lethal levels even if at times some frogs are affected. However, the effects of water chemistry and contaminants on free-living *R. pretiosa* are generally very poorly understood, and Jack Creek's hydrology may affect exposure by diluting contaminated surface water with spring water. This has not been studied to date.

Water quality of springs or pools may be compromised if cattle become entrapped in them, die, and decompose. This represents a potential threat to frogs that might use these locations as wintering sites.

Timber harvest

Timber harvest may negatively impact *R. pretiosa* habitat by leading to increases in the amount of fine sediment washing into the Jack Creek system or by affecting succession patterns (Hayes 1998). The magnitude and importance of these potential effects are unknown, and must be balanced against the threat of lodgepole encroachment and shading of oviposition habitat and the need to manage fuel loads in the surrounding forest. Timber harvest may benefit frog habitat by removing encroaching confers that can shade open-water habitat, and by potentially allowing more water to return to the system with the removal of trees (e.g., Burton 1997).

Road building associated with timber harvest may alter hydrological regime or increase the risk of invasive species introductions. Roads may alter overland flow, culverts may increase sediment transport, and both roads and their associated culverts may create barriers to *R. pretiosa* movement.

Altered hydrological regimes

The greatest threats to the hydrological regime of Jack Creek are likely climate change and loss of beaver. Changes in climate are predicted to reduce winter snowpack and decrease spring runoff from snowmelt (Melack et al. 1997). This may reduce the amount of water in the Jack Creek system in summer and fall. Successive years of drought from 2000 to 2010 reduced water table levels from 370 to 385 feet between 2001 and 2010 in a well located in the northwest corner of the southeast quarter section of 28S 10E Section 27, monitored by Oregon Water Resources (see http://www1.wrd.state.or.us/groundwater/obswells/waterlevels/waterlevel_KLAM000562.html). This decline may not reflect the water table under Jack Creek (M. Cummings, Portland State University, personal communication 2011), but it does give an idea of the magnitude of the drought in the region.

The drought occurred during the time period in which *R. pretiosa* in Jack Creek dramatically declined. How much drought influenced these declines is unclear. Remnant beaver dams continued to degrade over this time, and vegetative succession was not halted by any large-scale disturbance. Open-water habitat may have declined through this period because of all of these factors. In a study conducted in Elk Island National Park in Alberta, the number of beaver lodges explained more of the variability in open-water habitat than precipitation and temperature (Hood and Bayley 2008). Beaver ponds were found to buffer the effects of severe drought (Hood and Bayley 2008). Beaver ponds provide a more even water discharge throughout the summer (Rosell et al. 2005). Loss of the last vestiges of beaver dams in Jack Creek may exacerbate the effects of low-water years.

Beaver were active historically along several reaches of the Jack Creek frog habitat. Beaver are well known for their impacts on hydrology (Rosell et al. 2005) and they likely maintained extensive open-water habitat used by *R. pretiosa* when the beaver were present. Beaver ponds create habitat for a number of amphibian species (Stevens et al. 2007). The old remnants of beaver dams still appear to have high habitat value. The vast majority of current breeding activity on Lower Jack reach is associated with the one remnant beaver dam that still holds back water (C. A. Pearl, USGS, personal communication 2011).

Hydrological regimes in Jack Creek may be affected by grazing, particularly in drought years when removal of water through drinking by livestock may be proportionately greatest. However, whether this constitutes enough water loss to be of concern is not known. Cattle trails may increase water flow off meadows, reducing the amount of water in shallow flooded habitat. In addition, there are likely to be interactive effects between grazing and drought. Cattle and frog conflicts become more likely under conditions of limited stream flow especially if cattle are using the creek for drinking. If cattle are using the same few pools as the frogs, the risks of direct impacts such as trampling, or indirect effects such as reduced water quality are increased.

Lodgepole pine encroachment and increased stand density also have the potential to alter hydrological regimes by decreasing surface water flow, particularly in summer, as a result of water losses through leaf transpiration (Knight et al. 1985, Burton 1997).

Roads built for logging may alter hydrological regime by altering overland flow. Road culverts may alter stream flow if not properly installed, causing erosion and increased sediment loading.

Isolation from other spotted frog populations

The Jack Creek population of spotted frogs is approximately 20 miles from the nearest known population of *R. pretiosa* located on the Williamson River, and typically there is only a brief hydrologic connection during wet years (A. Markus, USFS, personal communication 2011). The low genetic diversity in *R. pretiosa* overall suggests that all populations including Jack Creek have been isolated from each other for some time, leading to the loss of genetic diversity in the absence of mixing among populations (Funk et al. 2008, Blouin et al. 2010). This is unlikely to change in the near future, and the risks of stochastic events causing extinction are significant particularly while the Jack Creek population is so small.

Disease and UV damage

The fungus *Batrachochytrium dendrobatidis*, the causal agent behind chytridiomycosis, has been found in the Jack Creek spotted frog population and in all other populations of *R. pretiosa* that have been tested. Although prevalence of infection increased over the course of summer at low elevations during the study, this was not true of high-elevation sites such as Jack Creek (Pearl et al. 2009). Although infections in larvae were uncommon (2.8%), prevalence among metamorphosed frogs was quite high (75% in juveniles and 56% of adults). However, no die-offs were seen, nor were any outward signs of infection noted in any of the captured frogs. Although chytridiomycosis is prevalent, the immediate impacts are not clear (Pearl et al. 2009). Researchers exposed *R. pretiosa* from one population to two different strains of *B. dendrobatidis* in the laboratory. They found that *R. pretiosa* were able to clear resulting *B. dendrobatidis* infections (Padgett-Flohr and Hayes 2011). However, infected frogs gained less mass over the course of the experiment, suggesting an energetic cost to dealing with the infection (Padgett-Flohr and Hayes 2011).

R. pretiosa appears resistant to the effects of ambient UV radiation (Blaustein et al. 1999).

Oomycetes was confirmed on *R. pretiosa* eggs from Jack Creek (Petrisko et al. 2008). It remains unclear how this fungus might affect *R. pretiosa* at this time. Accidental introduction of new disease is an ongoing threat to isolated *R. pretiosa* populations.

Research effects

Research can have negative impacts on the organisms under study, although these impacts rarely are specified or quantified. Handling animals causes stress and possible injury, which may lead to reduced survival and breeding potential. Researchers may also act as unwitting vectors for disease.

DESIRED SITE CONDITONS

Desired site conditions are a vibrant, fully functioning riparian system with increasing *R. pretiosa* populations that expand first into formerly occupied habitat and later into areas currently identified as potential habitat. Restored hydrological conditions include sunny, unshaded open water for breeding and rearing, with plentiful off-channel shallows. Deep water and springs for overwintering would also help maintain summer water. Desired site conditions also include maintenance of appropriate vegetation structure in breeding pools and summer areas, and a restored water table. Other desired conditions are off-channel frog habitat in the form of ponds and springs that maintain water throughout the active season, and pools and channels within the creek that are sufficiently deep to provide over-winter habitat.

HABITAT GOALS AND OBJECTIVES

The goal of this management plan is to restore habitat such that *R. pretiosa* can expand and recolonize formerly occupied habitat along Jack Creek. Specific objectives might include:

1. Create more open-water habitat for adult frogs.
2. Maintain breeding and rearing habitat.
3. Restore the site's hydrology.
4. Protect the site from invasive species.
5. Reintroduce natural disturbance regimes such as beaver and possibly low-intensity fire.

6. Prevent the introduction of bullfrogs and any other non-native vertebrates, including fish.
7. Manage vegetation in the meadows so that appropriate breeding and rearing habitat is available in the form of shallow pools with moderate vegetation density.
8. Prioritize restoration on the Upper Jamison and Lower Jack reaches to maximize the likelihood that the existing population may expand. These reaches are particularly important to the recovery of *R. pretiosa* in Jack Creek because they harbor the last known breeding activity *of R. pretiosa* in the system. Once restoration activities have been completed in occupied habitat, shifting efforts to previously occupied habitat would help ensure that *R. pretiosa* would find suitable conditions for population expansion.
9. Cooperatively manage spotted frog habitat found on Iverson Ranch private lands and National Forest System lands. Private lands harbored *R. pretiosa* in the past and currently support much of the known breeding activity in Jack Creek. With proper restoration and management, the private lands offer some of the most immediate options for reoccupation of historical habitat. Cooperative management would make the possibility of the reintroduction of beaver far more likely, as Oregon Department of Fish and Wildlife requires approval of all landowners within 5-6 miles of the release site (http://www.dfw.state.or.us/wildlife/living_with/docs/Guidelines_for_Relocation_of_Beaver_in_Oregon.pdf).

COMPLIANCE WITH THE WINEMA LAND AND RESOURCE MANAGEMENT PLAN AND OTHER REGULATORY DIRECTIVES

The Winema Land and Resource Management Plan (1990) provides direction for management of Management Area 8 and 12. The goals and desired future condition are quoted below. Refer to the Winema Forest Plan for further details relating to standards and guidelines.

Forest Plan Goals and Objectives

The desired site conditions are compatible with all goals and objectives identified in the Winema Land and Resource Management Plan including Management Goals 5, 6, 7, 16, and 23. They also meet Forest-wide Standards and Guidelines for Endangered, Threatened, or Sensitive Species, Riparian Ecosystems, and Noxious Weed Control.

Management Area 8 – Riparian Areas

Goals: "Riparian area management is designed to protect soil, water, wetland, floodplain, wildlife, and fish resource values associated with riparian vegetative communities and adjacent drier ecosystems. Management emphasis is on water quality, deer fawning, wildlife habitat, and aquatic ecosystems. Existing conditions will be maintained or enhanced."

Desired Future Condition: "The desired future condition is riparian vegetative communities containing openings and meadows interspersed with stands in various successional stages. These stands differ in age, species composition, density, and size. Riparian vegetation provides wildlife habitat and adequately protects floodplains, bank stability, and water quality. Few roads and other facilities are present within the riparian area.

Management Area 8A – Riparian Areas Adjacent to Class I, II, and III Streams

Goals: "This management intensity is designed to maintain or improve riparian areas associated with Class I, II, and III streams and with lakes. Management practices shall meet (as a minimum) the substantive State Best Management Practices **(**BMP**)** requirements and other considerations required by the National Forest Management Act (NFMA) and other authorities for the protection of the soil and water resources."

Desired Future Condition: "**1)** A diversity of vegetative types ranging from open meadowlands to forested land to provide in-stream cover for fish, bank, and floodplain stability, and habitat for big game and nongame wildlife, and 2) high standards of water quality in terms of temperature, turbidity, and bank stability for fisheries and recreational uses and to meet State water quality standards.

Management Area 8B – Riparian Areas Adjacent to Class IV Streams

Goals: "This management area is designed to minimize adverse downstream impacts on Class I, II, III streams, to protect bank and channel stability of Class IV streams, to meet or exceed BMPs, and to provide quality habitat for nongame and big game wildlife species."

Desired Future Condition: "Provide a vegetative condition that shall protect stream banks from erosion and protect downstream values. Provide cover and forage for big game and nongame wildlife."

Management Area 8C – Moist and Wet Meadows

Goals: "This management intensity is designed to protect, maintain, or enhance moist and wet meadows and associated wildlife habitat. Maintain or improve meadow condition, and prevent gullying or dropped water tables. Reduce encroachment of confers on existing meadows."

Desired Future Condition: "The desired future condition of moist and wet meadows is the maintenance of quality meadow condition and no encroachment by conifers and providing adequate forage for big game and livestock. Also desired is a lack of gullying or lowered water tables which drain the meadows."

Management Area 12 – Timber Production

Goals: "Management Area 12 is designed to produce a high level of growth and timber production with considerations for economic efficiency and resource protection."

Desired Future Condition: "The desired future condition is a mosaic of healthy sands capable of sustaining high levels of timber production. Such stands typically are comprised of trees that are growing rapidly and have well-developed crown ratios and low levels of mortality."

This SMP considers the Forest Service Objectives for Designated Sensitive Species,

FSM 2670.22:

> 1) develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions; 2) maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands; and 3) Develop and implement management objectives for populations and/or habitat of sensitive species, as well as FSM 2670.32.3 "avoid or minimize impacts to species whose viability has been identified as a concern".

POTENTIAL MANAGEMENT ACTIONS

Prioritizing restoration on the Upper Jamison and Lower Jack reaches would help to maximize the likelihood that the existing population would expand. These reaches are particularly important to the recovery of *R. pretiosa* in Jack Creek because they still support known breeding activity and provide habitat for all life stages of *R. pretiosa*. Once restoration activities have been completed in this core occupied habitat, shifting efforts to previously occupied habitat would help ensure that *R. pretiosa* would find suitable conditions for population expansion. Table 2 below provides specific management actions that could be undertaken and suggested timelines for implementation.

The Jack Creek population is at critically low numbers with fewer than twenty known breeding females. Because such small populations are prone to wide fluctuations solely due to chance, frog numbers are not reliable benchmarks for management actions. Instead, habitat characteristics can serve as restoration goals and triggers for changes in management strategy. Even if no frogs are detected in one or more years, maintaining habitat would protect any undetected animals in the system and maintain the integrity of the riparian wetlands. It would also allow for reintroduction if the population becomes extinct in the near term.

Reinforce existing beaver dams:

Lack of open water habitat may be one of the greatest threats to adult *Rana pretiosa* (C. A. Pearl, USGS, personal communication 2011, M. Hayes WDFW, personal communication 2011). Retaining the remaining remnant beaver dams has already been identified as a priority for conserving the remaining frog population (Jack Creek Spotted Frog meeting, May 11, 2010, meeting minutes). Due to the extremely small size of the breeding population, management actions should focus on both immediate habitat creation and long-term habitat maintenance.

Open water can be created and maintained in the immediate term by using lodgepole pine slash to reinforce existing abandoned beaver dams. This should be done with great care to avoid damaging the dams, and should not be done when frogs may be using the dams as over-wintering sites. Consultation with experts in hydrology may help in determining how dams should be reinforced. Protecting these remnant dams from cattle if needed may also help increase their

useful life, thus allowing more time for completing other habitat enhancement projects. Creating a structure to pool water to create frog habitat may be considered if it allows for passage of Miller Lake lamprey (*Lampetra minima*) and other aquatic organisms.

Stabilization of existing beaver dams can occur even if the four artificial ponds are created on Lower Jack as per an earlier management decision. The artificial ponds are unlikely to provide food or cover for at least a year while biological communities form. In addition, *R. pretiosa* growth rates increased with pond age at Dilman Meadows (Chelgren et al. 2008), suggesting that pond communities must mature to become good habitat. The ponds at Jack Creek may require more time to develop because of the additional thousand feet of elevation relative to the Dilman Meadows site. Enhancing the old beaver dams would help ensure that some habitat is still available until the artificial ponds are fully established, or beaver have created additional new habitat.

Replant and protect willow:

Willow provides food for beaver, allowing them to maintain or expand activities that create open water habitat. Willow also provides bank stabilization. Willow may need protection from cattle, particularly late in the season, to allow existing plants to regenerate and new willow to become established. A careful inventory of willow following an established and repeatable protocol may be needed to determine where replanting efforts are most needed, and to monitor restoration progress to determine when site conditions are suitable for beaver.

Reintroduce beaver:

The re-establishment of beaver into the Jack Creek system would restore a major historical component to the hydrological functioning. Beaver have the greatest potential to create and maintain appropriate open-water habitat for *R. pretiosa*, and to address some of the hydrological restoration issues such as incised stream sections. In order for beaver reintroduction to be successful, however, site conditions must provide adequate forage and protection from their predators until the beaver can begin creating shelter (see Appendix A for beaver reintroduction guidelines and other considerations). If these conditions are present in Jack Creek, particularly on the Lower Jack reach, beaver reintroduction could move forward at the earliest opportunity

following adequate planning and preparation to enhance the possibility of success. The artificial ponds may increase the likelihood of successful beaver reintroduction by offering the beaver immediate safety as they adapt to their new surroundings.

Beaver reintroduction would have a greater chance for success by working with Iverson Ranch, as Oregon Department of Fish and Wildlife requires approval of all landowners within 5-6 miles of the release site (http://www.dfw.state.or.us/wildlife/living_with/docs/Guidelines_for_Relocation_of_Beaver_in_Oregon.pdf).

Head cut and channel repair:

The head cut in the Upper Jamison and Lower Jack has not responded to past attempts to repair it. Appropriate technical expertise may need to be obtained to plan and execute a plan to stabilize and eventually restore this section of creek. All restoration sites should be monitored for invasive weed introduction if soil is disturbed, or if heavy equipment or material such as rock or fill is brought into Jack Creek. If fill is needed in the repair process, the repair may be coordinated with the creation of the temporary ponds if the ponds are built to minimize both the fill disposal issue and need to import fill to fix the head cut. Repair of head cuts and incised channels would help maintain the necessary hydrology responsible for *R. pretiosa* habitat. This may be particularly important for maintaining connectivity between habitat in the intermittent sections of Lower Jamison and reaches upstream with perennial flow.

Removal of lodgepole pine:

Other active restoration efforts might include removal of lodgepole pines that are encroaching on the meadows, potentially altering meadow hydrology. They also may shade critical breeding habitat. Longer-term efforts might include restoration of mixed stand structure in lodgepole pine as a step in restoring historical hydrological patterns in Jack Creek as well as restoration of habitat along reaches formerly occupied by *R. pretiosa*.

Initially, only trees that are likely to cause shading may need to be removed. If future monitoring or examination of historic photographs suggests that lodgepole encroachment is occurring at unacceptable rates such that beaver activity does not counterbalance encroachment,

further removal may be necessary to restore the meadows and accelerate recovery of hardwoods such as aspen and willow. Thinning of upland areas may also contribute to improved hydrological functioning by allowing more water to remain in the system (Knight et al. 1985, Burton 1997). Monitoring stream flow in conjunction with thinning operations may help determine the relative cost-benefit of this management action if its main rationale is habitat improvement for *R. pretiosa*.

The debris from lodgepole removal may need to be managed so that it does not increase fire risk. Ideally, it would also not be placed where it might block future cattle movements along the edges of the uplands off the meadows, or negatively impact sensitive plants. The debris may be used to help stabilize old beaver dams or provide readily available building material for newly introduced beaver. The debris may also serve as material to block access to established cattle trails across meadows as a step in their rehabilitation (see below).

Reintroduction of fire:

Careful and limited controlled burning may help keep the meadow system in an appropriate stage of vegetative succession for *R. pretiosa*. Controlled burns may also help in preventing lodgepole encroachment on meadows, and in maintaining more complex stand structure that in turn may help maintain water in the creek system.

Removal of Invasive Species:

Removing any established weeds including reed canary grass would help maintain appropriate vegetative structure for *R. pretiosa*. Monitoring restoration projects to ensure they do not introduce new invasive species may help catch invasions in time for effective, efficient control. Developing protocols for field personnel to follow to prevent seed or other matter from arriving on boots, gear, or equipment may help lower the risk of introductions in the future. Protocols may also help prevent heavy machinery used for timber harvest, ranching, or restoration activities from acting as vectors for invasive organisms. Methods for cleaning and disinfecting equipment and boots have already been developed for researchers working in aquatic systems and may provide the basis for expanded protocols for the Jack Creek system.

Threats of invasive plant establishment could also be reduced if protocols for personnel working within the Jack Creek system were developed to reduce the likelihood that mud, seeds, or other invasive species vectors are carried in on boots, gear, or personal equipment.

While grazing is still conducted on Jack Creek, regular surveys to ensure invasive weeds are not introduced from the cattle may be helpful in preventing weed establishment. Monitoring for noxious weeds may be needed after cattle are removed from reaches for restoration or for other reasons, as some invasive plants may be currently kept in check by grazing.

Prevention of disease introductions

Care should be taken to ensure that all field personnel, regardless of their duties, follow appropriate guidelines for cleaning equipment that might come into contact with water. This is particularly true for biologists working in aquatic systems. Developing protocols to disinfect gear prior to entering the Jack Creek system may help prevent the introduction of new diseases or other pathogens.

Minimizing the risks of research

All research proposals dealing with any aspect of Jack Creek should be carefully evaluated to ensure that the potential benefits of the new knowledge will outweigh the risks, the research will address the questions posed, and study design and sample sizes would allow robust inference. Protocols may need to be in place to minimize stress to the frogs and the risks of introducing new diseases or invasive species. Proposals for research should identify why previous work at other locations is not sufficient to address management and conservation needs at Jack Creek, and the likelihood that the project's outcomes will lead to better management.

Mowing of oviposition habitat:

Experimental work has shown that frogs selected mowed oviposition habitat and that these mowed areas had greater maximum temperatures than unmowed control areas (White 2002). This experiment could be repeated on Jack Creek to determine if vegetation matted down from the previous growing season affects maximum water depths or temperatures and whether frogs respond to vegetative removal. If so, mowing oviposition habitats, burning, or grazing to achieve a similar structure may improve habitat quality. This experiment would need to be

designed and carried out in collaboration with biologists knowledgeable about Jack Creek *R. pretiosa*.

Cattle trail restoration:

Cattle trails may have damaged hydrological function in meadows by increasing the rate of water drainage, reducing surface water for egg development and successful hatching. Cattle trails may therefore need rehabilitation, either using straw wattles or other techniques that minimize risk of damage to meadow soils or increased runoff of sediment. Cattle may need alternative pathways to prevent them from simply creating new paths across sensitive habitat. Pathways can be created in the uplands adjacent to meadows, and slash strategically used to further discourage cattle from using paths that are being restored. If off-channel ponds are created, sedge from the disturbed area might be replanted in cattle trails to help speed restoration of vegetation.

Cattle behavior suggests that new trails are likely to be formed as access to established trails is blocked (J. Robson, USFS, personal communication 2011). Ideally, individual trails should be evaluated for their impact on meadow hydrology and the time and effort spent restoring them allocated accordingly. Reducing the grazing interval from past season-long practices may lessen the likelihood that any new trails would become as damaging as in previous years. Salt can be used to encourage cattle to move throughout the system, preventing loafing only by water troughs. This would also help spread cattle grazing away from the immediate vicinity of the water trough and spread both potential impacts and grazing pressure throughout the meadow (J. Robson, USFS, personal communication 2011).

Cattle grazing:

Grazing may be a helpful tool in achieving habitat goals provided the cattle are properly handled. Grazing rotations that put cattle on meadows for a short period of time with more intensive grazing, utilize rest years, and vary when each meadow is grazed among years have the potential to minimize damage to key riparian habitat characteristics while still allowing resource utilization once restoration goals have been achieved. However, grazing would need to be conducted so that conflict with *R. pretiosa* is minimized, either when habitat availability declines with late-season water levels, or if resource utilization standards are exceeded. This could be

managed either through pre-determined grazing periods that are short enough to minimize potential impacts, or the use of management triggers.

Ultimately, the relationship between Jack Creek spotted frog populations and grazing is not understood well enough to confidently guide management. As grazing is reinstated on some sections of Jack Creek, carefully designed monitoring and preferably manipulative experiments may need to be undertaken. Feedback from these efforts can be used to ensure that grazing levels, intensity, and timing maximize the possible benefits and minimize the potential risks of grazing these reaches for *R. pretiosa* population viability. Any such work should be designed in consultation with biologists knowledgeable about targeted monitoring (Nichols and Williams 2006), and include input from range management specialists, hydrologists and botanists as appropriate to maximize the usefulness of the resulting data.

Given the interspersed patterns of land ownership by the Forest Service and Iverson Ranch, a cooperative approach to resource management may need to be developed for this area. See Appendix B for a thorough discussion of specific recommendations for grazing management for this section of Jack Creek, developed collaboratively through discussions between the Forest Service, Oregon Wildlife Institute and Iverson Ranch. This approach is not intended to preclude other options for grazing management, but rather provides one option that is both consistent with the recommendations in this SMP and developed through a collaborative process.

Adaptive management:

Restoration and management must often proceed without all of the desired information at hand. As much as possible, information needs should be identified and appropriate experimentation or targeted monitoring designed to fill those needs. Management actions, including all of the recommendations in this document, may need to be modified to incorporate any new knowledge. Examples include placing stream gauges above critical *R. pretiosa* habitat to monitor stream flow as an indicator of off-channel, open-water habitat availability, and evaluation of the effects of vegetation removal on oviposition sites.

Any such work would best be done with appropriate consultations with *R. pretiosa* biologists and other personnel as needed.

TABLE 2. Potential Management Actions. *Note that Timeline and Date Complete are goals and targets, subject to change as review processes and funding dictate. The life stages of* R. pretiosa *benefited by the desired site conditions are noted in parentheses, along with the seasonal habitat provided. (A=adult/juvenile/metamorph, L=larvae, E=egg; habitat denoted by O=oviposition, S=summer nonbreeding, W=winter). Actions requiring cooperation with Iverson Ranch are noted with asterisks in "Action Needed."*

THREAT	ACTION NEEDED	TIMELINE FOR ACTION, BUDGET	ACTIVITY LOCATION	HOW TO ACCOMPLISH	DESIRED SITE CONDITION	DATE COMPLETE
Altered hydrological regime, including loss of open water, channel head cutting and down cutting, and loss of beaver	Determine if sufficient willow forage available to proceed successfully with beaver reintroduction. Develop reintroduction plan with Iverson Ranch*	Winter 2011	Lower Jack meadow	Determine how much forage needed, FS and personnel with expert knowledge evaluate available forage on site if necessary	Sufficient willow forage to support beaver, stabilize banks, and create *R. pretiosa* habitat *(all stages, all habitat)*	March 2012
	Replant willow in lower Middle Jack, Upper Jamison and Lower Jack reaches if beaver forage insufficient*	Early spring 2012	Lower Jack and Upper Jamison	Follow methodology found to be successful in riparian restoration within the region	Sufficient willow to support beaver, stabilize banks, and create frog habitat *(all stages, all habitat)*	May 2012

THREAT	ACTION NEEDED	TIMELINE FOR ACTION, BUDGET	ACTIVITY LOCATION	HOW TO ACCOMPLISH	DESIRED SITE CONDITION	DATE COMPLETE
Stabilize old beaver dams before frogs move to over winter habitat	Fall 2012	Lower Jack Lower Middle Jack	Use lodgepole slash to enhance old dams, stabilize using appropriate techniques	Create more open shallow water *(all stages, O/S habitat)*	June 2012	
Continue thinning uplands, clean up slash before cattle reintroduced	Summer 2012	Lower Jack, Upper Jamison	Pile slash to prevent loss of access to uplands by cattle; use slash to create acceptable trail corridors	Cattle trails that follow upland contours rather than bisect sensitive meadow habitat *(all stages, O/S habitat)*	Fall 2013	
Altered hydrological regime, including loss of open water, channel head cutting and down cutting, and loss of beaver	Remove encroaching lodgepole from all reaches	Summer 2012	All reaches of Jack Creek	Remove conifers from meadows. Pile slash to avoid fire risk and forcing cattle into meadows.	Restored meadow extent and hydrology *(all stages, O/S habitat)*	Fall 2017

THREAT	ACTION NEEDED	TIMELINE FOR ACTION, BUDGET	ACTIVITY LOCATION	HOW TO ACCOMPLISH	DESIRED SITE CONDITION	DATE COMPLETE
	Repair head cuts, remove reed canary grass	Summer 2012	lower Middle Jack, Lower Jack and Upper Jamison Meadow	Consult riparian habitat specialists to determine effective repair strategy and weed removal.	Functioning hydrology with appropriate vegetative structure *(all stages, all habitats)*	August 2012
	Fence off Lower Jack and Lower Jamison*	Summer 2012	Between Upper and Lower Jamison, Middle and Lower Jack	Install permanent wire fence similar to current "frog fence" to keep cattle out of restoration area	Controlled access for cattle to Middle Jack and Upper Jamison/Lower Jack meadows	October 2012
	Set up stream flow monitoring	Summer 2012	Top of Lower Jack, Upper Jamison	Consult with hydrologists to set up stations, monitor throughout summer	Knowledge of how stream flow and surface water availability are correlated	2022
	Reintroduce beaver if habitat will support	Summer 2012	Lower Jack	Consult with ODFW and private groups	Active beaver colony maintaining hydrology *(all stages, all habitat)*	August 2012
	Prevent beaver from being trapped	Fall and Winter each year	All sections of Jack Creek	Communicate with ODFW to ask area trappers not to trap Jack Creek	Continuing beaver presence along Jack Creek *(all stages, all habitat)*	Ongoing

THREAT	ACTION NEEDED	TIMELINE FOR ACTION, BUDGET	ACTIVITY LOCATION	HOW TO ACCOMPLISH	DESIRED SITE CONDITION	DATE COMPLETE
	Repair cattle trails in meadow	Spring 2013	lower Middle Jack, Lower Jack, Upper Jamison	Use straw wattles or other techniques in consultation with restoration specialist	Slow overland water flow, allow recovery of trails *(eggs, larvae, oviposition and summer habitat)*	July 2013
Altered Habitat Quality	Remove invasive plant species	Summer 2013	All reaches of Jack Creek	Survey all reaches to ensure no reed canary grass or other invasives have established, remove if found	No invasive plant species that may modify habitat quality are present *(all stages, O/S habitat)*	October 2013
	Grazing to maintain low vegetation height if restoration goals met	Summer 2014	lower Middle Jack, Lower Jack, Upper Jamison	Design adaptive management study with appropriate consultation	Reduced vegetation height and density *(all stages, O/S habitat)*	September 2014
Isolation of Jack Creek population	Monitor *R. pretiosa* with USGS cooperative agreement	Spring 2012	Jack Creek	Annual egg mass counts and other monitoring as management actions undertaken	Increase all life stages of *R. pretiosa*	2022

THREAT	ACTION NEEDED	TIMELINE FOR ACTION, BUDGET	ACTIVITY LOCATION	HOW TO ACCOMPLISH	DESIRED SITE CONDITION	DATE COMPLETE
Altered hydrological regime, including loss of open water, channel head cutting and down cutting, and loss of beaver, continued	Replant willow in riparian areas of upper Middle Jack, Moffit, Upper Jack, and Lower Jamison*	Spring 2014	upper Middle Jack, Moffit, Upper Jack, and Lower Jamison	Use techniques and timing found to be successful in riparian restoration within the region	Sufficient willow to support beaver, stabilize banks, and create *R. pretiosa* habitat (all stages, all habitats)	Fall 2015
	Survey for and repair any head cuts and down cut channels	Spring 2014	Upper Jack, Moffit, upper Middle Jack, Lower Jamison	Consult riparian restoration specialist to determine most effective repair strategy	Stream channel that is fully connected to its floodplain (all stages, all habitats)	Summer 2016
	Repair cattle trails in meadow areas	Spring 2016	Upper Jack, Moffit, upper Middle Jack, Lower Jamison	Use straw wattles or other techniques in consultation with riparian restoration specialist	Slow overland water flow, allow recovery of trails (all stages, all habitats)	July 2017

THREAT	ACTION NEEDED	TIMELINE FOR ACTION	**Activity Location**	HOW TO ACCOMPLISH	DESIRED SITE CONDITION	DATE COMPLETE
	Fence Moffit pasture*	Summer 2017	Moffit	Fence with barbed wire and steel posts similar to current frog fence	Allow Moffit to be managed as part of rotational grazing as riparian pasture (all stages, all habitats)	October 2017
	Adaptive management	2012	All reaches	Design monitoring strategies and experiments to gauge results of restoration work	Management that is informed by results of past actions (all stages, all habitat)	ongoing

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APPENDIX A: RELOCATING BEAVER TO JACK CREEK

Relocating beaver as part of restoration activities has increased dramatically in recent years. The Oregon Department of Fisheries and Wildlife (ODFW) has drafted relocation guidelines for relocating beaver to new sites from areas where they have been causing damage. There are, however, some site-specific considerations for Jack Creek. The high elevation of this site (5,500 feet) and annual snow cover may force beaver to rely on stored food for winter forage. Forage cut for winter during the growing season may have a very different nutrient profile than vegetation cut late in the year, after plants have already begun translocating resources into their roots. Beaver may require a larger forage base at the higher elevations because reduced growing season length may affect the resiliency of food plants to grazing by the beaver.

Introducing animals into Jack Creek in August allows the animals some weeks of high-quality summer forage and several months before snowfall limits their foraging and activity. The ODFW guidelines already recognize the value of moving a pre-existing social group such as a mated pair or family unit. This has been supported by data from ongoing research at Oregon State University (J. Taylor, USDA Wildlife Services and OSU, personal communication 2011).

Selection of release sites selection has been shown to affect the probability of reintroduction success (J. Taylor, USDA Wildlife Services and Oregon State University, personal communication 2011). Beaver need either a site for a bank den or a root wad in a deep pool to use as shelter before a lodge can be built. Seven of 14 beaver relocated in the southern Umpqua were lost to predators, primarily cougars (S. Petrowski, Southern Umpqua Rural Community Partnership, personal communication 2011). Cougar are present in the Jack Creek region, and beaver will require adequate shelter immediately upon release to survive. This may be provided by the artificial ponds that are already in the process of being constructed. If for some reason the artificial ponds are not created before beaver release is judged to be otherwise feasible, other steps might be taken to ensure newly released beaver will have immediate shelter.

Oregon Department of Fish and Wildlife currently requires that landowners with 5-6 miles up- and downstream of reintroduction sites agree to the reintroduction. Beaver reintroduction

therefore may need to be undertaken only after Iverson Ranch has formally agreed to any reintroduction plan. The reintroduction plan might address issues such as what levels of damage by the beaver to Iverson Ranch resources would be considered unacceptable and grounds for steps to protect resources, and how damage could be mitigated. The plan may also identify when to remove some or all of the beaver if other solutions to damage problems cannot be found. Resources that may need to be considered include roads, culverts, fences, and timber. Potential solutions to conflicts might also be identified if possible, along with who would be responsible for which actions. Such up-front work may help greatly in reducing potential conflicts in the future.

To view the Oregon Department of Fisheries and Wildlife (ODFW) document, "Guidelines for Relocation of Beaver in Oregon", go to http://www.dfw.state.or.us/wildlife/living_with/docs/Guidelines_for_Relocation_of_Beaver_in_Oregon.pdf

The potential for trapping exists for any population of beaver reintroduced into Jack Creek. Beaver on public lands are considered "protected furbearers" (see Oregon Revised Statute 496.004 and Oregon Administrative Rule 635-050-0050, both implemented by ODFW). Beaver may be trapped throughout Klamath County from November 15-March 15 at least through 2012 (see http://www.dfw.state.or.us/resources/hunting/small_game/regulations/docs/2010-2012_Furbearer_Regs.pdf). Trappers must obtain a license, and they are required to fill out forms indicating their take prior to license renewal the following year.

Oregon Revised Statute 610.105 (Authority to control noxious rodents or predatory animals) states:

"Any person owning, leasing, occupying, possessing or having charge of or dominion over any land, place, building, structure, wharf, pier or dock which is infested with ground squirrels and other noxious rodents or predatory animals, as soon as their presence comes to the knowledge of the person, may, or the agent of the person may, proceed immediately and continue in good faith to control them by poisoning, trapping or other appropriate and effective means. [Amended by 1971 c.658 §30]"

Beaver on private lands are considered to be predatory animals under Oregon Revised Statute 610.002. This statute is implemented by Oregon Department of Agriculture, and landowners do not need a permit or license from ODWF to trap or remove beaver that are causing damage on private land. A trapper hired to remove beaver on private land may need licensing, however.

Working with both regional and local trappers and landowners upon whose lands beaver activity may occur following a reintroduction may greatly enhance the chances that a successful reintroduction will not eradicated through trapping.

APPENDIX B: POTENTIAL ACTIONS FOR GRAZING MANAGEMENT

Rationale:

Approximately one half of occupied spotted frog habitat exists on Iverson Ranch private lands, providing the motivation to develop cooperative management strategies between the Ranch and US Forest Service. The potential management actions listed in this appendix were developed through collaborative discussions between the U. S. Forest Service, Oregon Wildlife Institute, and Iverson Ranch personnel. These options for grazing management could be considered through the NEPA process in the future.

Cooperative management of both private and FWNF parcels that are occupied by *R. pretiosa* would allow for more efficient use of resources and a greater likelihood of population recovery. Breeding has been documented primarily on Lower Jack and Iverson Ranch lands in Upper Jamison in recent years (NRIS database, C. A. Pearl, USGS, personal communication 2011), and adult frogs have consistently been detected on both FWNF and private lands throughout the Jack Creek System. Breeding was once more common on Iverson Ranch land in Moffit and it also occurred on Lower Jamison. There is some evidence of frogs below Lower Jamison on FWNF lands. If the Jack Creek *R. pretiosa* population is to expand fully back into former habitat, private as well as FWNF lands would require restoration and management to enhance habitat suitability along the entire section of Jack Creek that may provide habitat.

Grazing is a historical use of this site, and may benefit *R. pretiosa* by helping to maintain the early seral stages in the vegetative structure and by removing biomass from oviposition sites (White 2002). However, grazing must be conducted in a manner to maximize the benefits of this activity to *R. pretiosa* while minimizing possible risks. Careful, targeted monitoring would allow the evaluation of the relationships between cattle grazing and *R. pretiosa* demographics and habitat.

Cooperative Management Considerations:

Occurrence of grazing:

There is no information available regarding the size and extent of *R. pretiosa* populations prior to the mid-1990s, although *R. pretiosa* managed to coexist with extensive livestock grazing for nearly a century prior to recognition of the species' presence on Jack Creek. Given the extremely small population sizes remaining on Upper Jamison and Lower Jack, grazing may need to be discontinued on these reaches until target habitat restoration goals are reached. These reaches contain the highest quality habitat although active management actions would be needed to provide conditions suitable for population expansion.

Cattle grazing might be reintroduced or continued on Upper Jack, Moffit, Middle Jack, and Lower Jamison initially while restoration efforts are underway in Lower Jack and Upper Jamison if they are needed to maintain a reasonable grazing rotation. Grazing may need to be suspended in Upper Jack, Moffit, Middle Jack, and Lower Jamison meadows once the focus of restoration shifts to them following the restoration of Lower Jack and Upper Jamison. Alternatively, fencing may be sufficient to protect restoration areas or sensitive resources. Maintaining flexibility in grazing rotations and providing a means of reducing pressure on reaches with frog populations if surface water drops to critical levels will be important to maintaining cooperative management.

Once habitat conditions have been restored particularly in Lower Jack and Upper Jamison Meadow, limited grazing may be reintroduced in these meadows, but as part of a carefully designed and controlled experiment to determine optimum duration and intensity that would remove biomass without damaging the creek banks or other sensitive areas. Some experimentation in an adaptive management framework may be very helpful to determine grazing strategies that would maintain appropriate vegetation structure while minimizing risks to frog habitat. This would require close cooperation between the range specialist, Iverson Ranch,

and spotted frog biologists to determine the optimum grazing strategy that is also practical for ranching, particularly on the private parcels.

Intensity of Grazing:

Managing grazed reaches of Jack Creek that are also frog habitat according to Forest Plan standards for riparian grazing might be considered. Grazing may benefit *R. pretiosa* by maintaining a more appropriate vegetative structure than would exist if no grazing occurred. Grazing to riparian pasture standards is generally appropriate along Jack Creek because the reduced utilization standards (35%) would provide better protection for willow and other sensitive vegetation along the creek than would standard pasture utilization standards (40%) while removing biomass from areas used by ovipositing frogs and larvae, thus increasing habitat suitability.

Timing of grazing:

Grazing on frog habitat can be timed to reduce the risks of direct interactions between cattle and frogs. Avoiding grazing during the spring breeding season may prevent possible direct impacts such as trampling of egg masses. If adequate surface water and pools exist, conflicts between cattle and frogs may be minimal. Use of off-channel watering tanks has the potential to further reduce the risks of cattle trampling either tadpoles or adult frogs, and reduce the possible impacts of grazing on water quality.

Timing of grazing may also help to protect riparian vegetation. Willow becomes more attractive to cattle in the fall (J. Robson, USFS, personal communication 2011). Browsing on willow may increase the time needed to develop an adequate forage base for the reintroduction of beaver. Heavy elk browse prevented recovery of willow cut by beaver (Baker et al. 2005), so careful monitoring of willow stocks in areas with grazing may be needed. Cattle browse willow most heavily late in the season (J. Robson, USFS, personal communication 2011). Although habitat restoration could ultimately reduce direct interactions between frogs and cattle, grazing in August and September may still need to be limited or tightly controlled to protect riparian resources.

Managing grazing during low-water years:

Grazing may need to be avoided on *R. pretiosa* habitat during years when off-channel surface water declines below a pre-determined, agreed-upon threshold, when low water levels increase the potential for negative interactions. Determining the extent of surface water that will be present based on SNOTEL data is currently not possible, as this region has not been adequately characterized (M. Cummings, Portland State University, personal communication 2011). Further hydrological research in these reaches may allow evaluation of SNOTEL data as an indicator of summer surface flow.

Alternatively, surface water availability may correlate with readings from a stream gauge placed within the creek just above reaches with spotted frog activity; this may be sufficient to forecast when cattle need to be removed from *R. pretiosa* habitat. Until such a measure is refined, advance planning for low surface water availability may not be possible, and grazing decisions may need to be subject entirely to real-time measurements of stream flow. A "low-water year" grazing rotation may need to be determined in advance for these years. The earlier in the season any decision regarding whether grazing should be suspended because of inadequate surface water is made, the more flexibility there may be in determining alternatives.

Once sufficient open-water habitat has been created either by artificial means or by beaver, the system may retain enough surface water even in low-flow years to prevent the need to move cattle elsewhere.

Grazing during high-water years:

If adaptive management and ongoing research indicate that grazing is important in maintaining early seral vegetative stages and appropriate habitat conditions for *R. pretiosa*, the frogs may benefit from cattle grazing even in wet years when range readiness standards would not typically allow grazing. Appropriate monitoring may need to be carried out and adjustments to management made accordingly.

Management of woody debris following lodgepole pine removal:

Cattle readily create and follow trails to reach loafing areas, water, salt, and grazing areas. Currently, lodgepole pine slash has been left scattered in the uplands adjacent to the meadows, and in many areas the piles block upland cattle trails. Slash may need to be placed so that cattle can access the upland areas adjacent to the meadows, and use them for movement. Slash may also be used to discourage use of trails that lead through sensitive habitat such as oviposition sites.

Off-channel watering tanks:

Off-channel watering tanks have the potential to decrease conflicts between cattle and frogs during summer, when water resources decline. Cattle also use the current off-meadow watering areas on Upper and Lower Jamison for loafing (K. Little, Iverson Ranch, personal communication 2011), thus reducing time spent on the meadows while the cattle are not actively grazing. Placing salt near watering troughs initially increases the incentive for cattle to travel to the troughs. Creating travel corridors along meadows so that cattle can reach water troughs without having to move along the edges of meadows may also reduce negative impacts of cattle trails on meadow hydrology. Off-channel water may need to be provided in all areas to be grazed prior to cattle turnout. Once cattle have become accustomed to using the troughs, salt may then be used to spread cattle throughout the pasture to prevent intense grazing pressure on meadows in the immediate vicinity of the troughs (J. Robson, USFS, personal communication 2011).

Fencing:

The current fence between Upper and Lower Jamison meadows may need to be expanded to prevent cattle from accessing Upper Jamison during its restoration. In addition, Middle Jack may need additional fencing to allow limited grazing there during the restoration activities on Upper Jamison and Lower Jack; this fence may be useful in incorporating rotational grazing as meadows meet restoration goals.

Areas where cattle have been known to become mired in the past can be made less accessible to cattle either by fencing, strategically placed slash, or other means. Cattle dying in springs used

by frogs not only represent a potential threat to suitable water quality, but a significant economic loss to Iverson Ranch. Dead cattle may need to be removed from known overwintering locations if feasible. The two areas that have been problematic in the past are on Upper Jack and Upper Jamison. The Upper Jamison springs have been fenced, but the fencing has not held up well. Repair and possibly a redesign may be needed. The spring in Upper Jack is adjacent to a fen, and both features would benefit from permanent fencing if possible. The size and location of the fenced area should be determined by mutual agreement between Iverson Ranch and the US Forest Service.

In addition, the entire Moffit meadow may need to be fenced so that it may be managed to riparian pasture standards and grazed as part of a multi-pasture rotational grazing system. Fencing initially may be used to protect habitat restoration work conducted within this meadow, when the focus of restoration shifts to Moffit

Restoration areas may require temporary fencing to protect them from cattle at least initially. Such sites may include rehabilitated trails, excavated ponds, and newly planted willow. Although permanent fencing in the meadows is challenging, temporary electric or other fencing that is set up prior to turning out cattle into the reach may be a workable alternative.

Beaver reintroduction:

Specific considerations regarding beaver reintroduction are given in Appendix A. Considerations relevant to grazing include the possible protection of beaver dams or undercut banks beaver may use for shelter from trampling by cattle as well as protection of willow stocks from too much browsing.

Triggers for modifying grazing:

Potential triggers that prompt changes in grazing management may include measurements of stream-bank vegetation such as stubble height, percent of stream bank damaged by livestock, amount of browse on willow or aspen, and amount of surface water or channel flow in the focal meadow. All of these measures could be based on measurement of system variables at the threshold of conditions identified as unacceptable for continued grazing.

For example, a water flow meter may be installed at the top of Lower Jack to track creek volume over the course of the summer. When off-channel water levels decline so that off-channel habitat is no longer adequate for frogs to remain dispersed throughout the meadow, grazing may need to be discontinued. Measurements over several years may allow the identification of a flow point at which moving cattle from Lower Jack may need to be initiated before the off-channel water situation becomes critical. Similarly, adult frogs may benefit from some overhanging vegetation along stream banks, which provides cover while not impacting water temperature. Determining whether the riparian utilization standards adequately protect stream-bank vegetation structure may lead to the development of a specific stubble height trigger point instead.

Developing these trigger points would require adaptive management, such that measurements are taken over the course of a grazing rotation along with riparian pasture utilization measurements to determine whether monitoring methods are adequately protective. Trigger points offer flexibility in the timing and duration of cattle grazing, but may also create unacceptable uncertainty for Iverson Ranch in terms of managing their herd.

Future considerations:

If there is sufficient open-water habitat and grazing is sufficiently managed, grazing may not cause direct conflicts with *R. pretiosa.* Instead, the greater likelihood for conflict may be through habitat alteration. Developing monitoring strategies to track riparian condition relative to grazing use may greatly aid in developing adaptive management strategies.

Once beaver are present, it is expected that the biomass of willow would decline because of feeding pressure exerted by the beaver. Some additional willow loss from late-season cattle browsing at this stage may need to be kept to a low level (Baker et al. 2005). Monitoring in an adaptive management framework would help identify what browsing levels are acceptable. Beaver are expected to maintain a presence in Jack Creek for at least a few years until willow and other food plants are exhausted. Depending on frog population sizes and other management goals, further restrictions on late-season grazing to enhance willow recovery may be considered at that time.