CALCULATING RESOURCE COMPENSATION: AN APPLICATION OF THE SERVICE-TO-SERVICE APPROACH TO THE BLACKBIRD MINE HAZARDOUS WASTE SITE

by

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National Oceanic and Atmospheric Administration
Damage Assessment and Restoration Program
Technical Paper 97-1

October 16, 1998

I. DAMAGE ASSESSMENT AND COMPENSATORY RESTORATION

A. Background

In the U.S., the atmosphere, oceans, estuaries, rivers, and plant and animal species are public trust resources. The primary and most recent federal statutes containing provisions establishing management agencies as trustees of natural resources are the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, more commonly known as Superfund), the Oil Pollution Act (OPA), and the National Marine Sanctuaries Act (NMSA). These Acts call on the President and state governors to designate officials to serve as trustees for natural resources on behalf of the public. Trustees, then, assess and recover damages to trust resources resulting from a discharge of oil, a release of a hazardous substance, or physical damage.

Under all three statutes, natural resource damage claims are based on the restoration of public resources and have three basic components. The measure of damages is (1) the cost of restoring, rehabilitating, replacing, or acquiring the equivalent of the damaged natural resources (primary restoration); (2) the diminution in value of the natural resources pending recovery of the resource to baseline,[1] but-for the injury (interim lost value); and (3) the reasonable cost of assessing those damages. The first component, primary restoration, provides for restoration of injured resources to their baseline level. The second component, compensatory restoration, compensates the public for reductions in the value of resource services pending recovery of the injured resources. Jones and Pease (1997) provide an in-depth discussion of resource-based measures of compensation in natural resource liability statutes.

In this paper, we focus on the interim loss portion of a damage claim and present an integrated framework of biology and economics for determining the scale of compensatory restoration actions appropriate to compensate for the interim loss of natural resources and services. This service-to-service approach to scaling is an in-kind approach to compensation that requires equivalency between the values of resources and services lost and resources and services to be gained through compensatory restoration. We first introduce the service-to-service approach for determining the scale of compensatory restoration. We then summarize a completed damage assessment case to demonstrate the service-to-service scaling approach.

B. Scaling Compensatory Restoration

A restoration action includes both a primary and compensatory component. The primary action restores the injured resources and services to their levels in the absence of injury, while the compensatory action compensates the public for lost resources and

[1] Baseline refers to the condition of natural resources and services that would have existed had the incident not occurred.

services during the interim.[2] If the primary action can not restore the resources and services to baseline, the compensatory action must provide compensation for the continuing injury.

The process of "scaling" a compen satory restoration action involves adjusting the size of the restoration action to ensure that the value of resource and service gains equals the value of interim losses due to the incident. Compensatory restoration generally involves enhancing resources or providing replacement resources. Because the duration of the injury differs from the lifespan of the replacement action, equivalency should be calculated in terms of the present discounted value of service flows lost due to resource injuries and gained due to compensatory resource enhancement or creation.

Under OPA, the highest priority compensatory restoration actions are those that restore the equivalent of the injured resources. Such actions provide resources and services of the same type and quality and of comparable value as those injured. If the actions do not provide a reasonable range of alternatives, the trustees may identify actions that, in their judgement, will provide resources and services of comparable type and quality as those injured.

The appropriate scaling approach depends on the type of available replacement resources and services relative to those injured. The two major approaches are the service-to-service or resource-to-resource approach and the valuation approach. The former approach (hereafter referred to as service-to-service) is a simplification of the valuation approach and is used when the injured and replacement resources and services are of the same type, quality, and comparable value. The valuation approach applies under conditions of comparable type and quality, but not of comparable value.

1. The Service-to-Service Approach

The service-to-service approach requires that the lost and restored resources and services be the same type and quality, and of comparable value. In other words, the injured and compensatory resources must demonstrate the same capacity and opportunity to provide services, and provide similar payoffs in human benefits.[3] In this context, scaling analysis simplifies to selecting the scale of a restoration action for which the present discounted quantity of replacement services equals the present discounted quantity of services lost due to the injury.

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[2] The concept of services refers to functions a resource serves for other resources and for humans. For example, a wetland habitat may provide on-site ecological services such as faunal food and shelter, sediment stabilization, nutrient cycling, and primary productivity. Off-site services may include commerical and/or recreational fishing, bird watching along the flyway, and water quality improvements due to on-site water filtration.

[3] For further discussion about capacity, opportunity, and payoff of natural resources, see "Comparing Ecosystem Services and Values," prepared by Dennis King for the National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1997.

To implement service-to-service scaling, trustees must select a resource-based metric, for example number of fish or stem density (number of stems per unit area), as a proxy for injury to all services. The metric should represent differences in the capacity and opportunity of the injured and restored resources to provide services; further, the metric should capture differences in payoffs to human services. Then, the trustees may determine compensatory actions based on the resource metric. Other necessary conditions for service-to-service scaling include: changes in resources and services are sufficiently small that the value per unit of service is independent of the changes in the overall stock of resources; and the scope of the market is the same for injury and replacement resources.[4]

The following outlines a generic formula employed to calculate the scale of compensatory actions. We consider the case of a habitat injury where the habitat created provides the same type and quality of services that the injured habitat did prior to the injury.

$$\Sigma_n \Sigma_t \nu_n * (\text{loss in services / acre})_t * (1+r)^{-t} * \text{J acres of habitat injured} =$$

$$\Sigma_n \Sigma_t \nu_n * (\text{gain in services / acre})_t * (1+r)^{-t} * \text{C acres of replacement habitat}$$

where ν_n is the value per acre-year of injured habitat to individual n, r is the real rate of discount, and t denotes time in years. The value terms are equal and therefore cancel out of both sides of the equation under the conditions required for service-to-service scaling. Solving the equation for C acres of habitat, then, determines the scale of the compensatory restoration action.

2. The Valuation Approach

An alternative framework for scaling is the valuation approach; we include a discussion here only to mention the alternative to the service-to-service approach. Valuation is applicable when the injured and restored resources and services are not of the same type, quality, and value. The valuation (or value-to-value) approach calculates the present discounted value of gains from the proposed restoration actions and the present discounted value of the interim losses. Scaling an action then requires adjusting the size of restoration to ensure the present discounted value of action gains equals the present discounted value of the interim losses. In some circumstances, the "value-to-cost" variant of the valuation approach may be employed. With this approach, the restoration plan is scaled by equating the cost of the restoration plan to the value (in dollar terms) of losses due to the injury.

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[4] These market supply and demand conditions may not be met, for example, when considering the value of additional water when water is in abundant supply and the value of additional water during a period of water shortage. The loss in value per gallon of water from an incident that creates a water shortage may be substantially greater than the increase in value per gallon of water from compensatory water-enhancing projects once response or primary restoration actions have returned water levels to baseline conditions of abundance.

SERVICE-TO-SERVICE SCALING: AN APPLICATION TO THE BLACKBIRD MINE

A. The Mine Site

Blackbird Mine is an inactive mine site located in the Panther Creek drainage, a major tributary of the Salmon River in east-central Idaho. The Salmon River is a principal subbasin of the Snake River, which flows into the Columbia River. A ridge divides the site into two drainage basins, the Big Deer Creek drainage to the north, and the Blackbird Creek drainage to the south (see Figure 1). The mine site consists of approximately 830 acres of private land and 10,000 acres of unpatented mining claims held by private corporations on National Forest System lands (USDA Forest Service, 1991). Ninety-nine percent of the Panther Creek basin is National Forest; less than one percent is privately owned. Active mining, primarily of copper and cobalt, first began in the 1890s and continued intermittently until the late 1960s. The mine site includes approximately 10 miles of underground workings on twelve different levels, an 11 acre open pit, 2 million cubic yards of mill tailings, and 4.8 million cubic yards of waste rock. Contamination from the mine site enters Panther Creek through Big Deer and Blackbird Creeks.

Several studies from the last 25 years document releases of hazardous substances, including cobalt, copper, nickel, and zinc, from the mine site and identify actual or potential sources of those releases into Panther Creek and its tributaries. Sources of hazardous substances at the mine include waste rock and tailings piles, the open pit, road fill containing waste rock, dredge spoils along Blackbird Creek, and the underground mine workings (Bechtel, 1986). Releases of hazardous substances into area surface waters occur via three main routes: erosion and leaching from waste rock and tailings piles, discharges from adits (mine openings), and discharges of contaminated ground water from seeps and springs (Baldwin, 1977; Bechtel, 1986; ERT and Davies, 1981; and USDA Forest Service, 1979).

In 1992, the State of Idaho initiated a Natural Resource Damage Assessment for the Blackbird Mine. The State filed a natural resource damage claim pursuant to CERCLA. Subsequently, the United States on behalf of the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Forest Service (USFS) joined suit. State, NOAA, and USFS officials together comprised the trustee group that assessed natural resource damages.

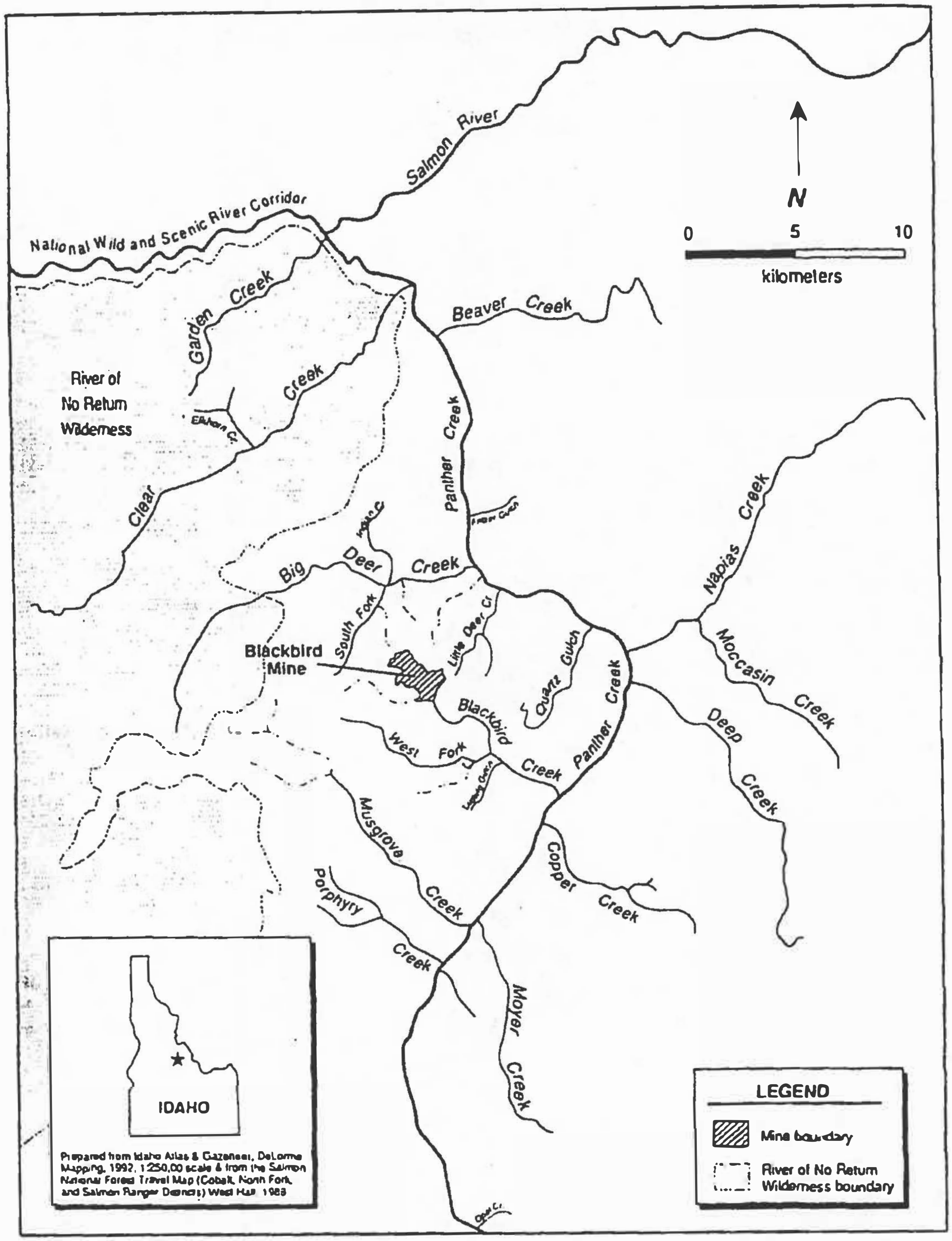

Figure 1. Blackbird Mine study area in the Salmon National Forest, Lemhi County, Idaho.

B. The Injury

The Panther Creek Drainage contains approximately 400 miles of perennial streams and and includes nearly 100 miles of streams suitable for anadromous fishes (USDA Forest Service, 1993). Highly contaminated discharge from the mine site directly affects habitat in the lower 25 miles of Panther Creek and presents a passage barrier that blocks access to remaining upstream habitat.

In support of litigation, the trustees conducted an injury assessment to evaluate the biological impact of releases from the Blackbird Mine. Injury was quantified by comparing the quality and quantity of the resources relative to baseline, where baseline is defined as the condition of the resource but for the discharge. The trustees established baseline from control areas, those areas unaffected by the discharge and otherwise similar to the assessment areas or resources, and from habitat evaluation of the affected stream. The injured resources included surface water, streambed fauna, and resident and anadromous fish.

Surface water resources in the Panther Creek drainage downstream of Blackbird Mine suffered injury throughout high and low flow conditions, notably from copper and cobalt releases. Field sampling done in 1993 and 1994 showed exceedences of the acute and chronic federal ambient water quality criteria (AWQC) for copper and the federal ambient water quality advisory (AWQA) for cobalt. For the baseline sample sites, no samples exceeded the copper AWQC or cobalt AWQA (RCG/Hagler Bailly, 1994; RCG/Hagler Bailly, 1995a). The injury to water quality affected the habitat services that would have been provided by Panther Creek, including the feeding, breeding, and nursery for fish.

Fine-grained sediments, aufwuchs,[5] and streambed fauna downstream of the Blackbird Mine releases contained higher concentrations of arsenic, cobalt, and copper than upstream reference areas; the difference in metal concentrations was as much as two orders of magnitude. In addition, all stations downstream of Blackbird Mine showed dramatic reductions in biomass and species composition of streambed fauna, indicative of impacts due to metals exposure (RCG/Hagler Bailly and Colorado State University, 1994). Injury to streambed components resulted in the loss of food for resident trout, anadromous species, and other aquatic animals.

Fish injury occurred for resident and anadromous species. Surveys conducted in 1994 showed that certain resident trout species, including cutthroat, bull and brook trout, were virtually absent from the Panther Creek drainage; resident cutthroat trout were abundant at the control sites. Densities of rainbow trout, another resident species, were lower in Panther Creek relative to the control sites. Surveys conducted by the Idaho Department of Fish and Game from 1984 to 1988 showed that densities of rainbow trout in Panther Creek upstream of Blackbird Creek (and hence upstream of mining influences)

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[5] Aufwuchs are plants and non-living materials that are attached to submerged rocks and provide habitat and nutrition for the streambed community.

were approximately 35-50 times higher than densities below Big Deer Creek and approximately seven times higher than at the mouth of Panther Creek with the Salmon River, 20 miles below the mine site (Crist, 1990). Rainbow trout are stocked annually in Panther Creek by Idaho Department of Fish and Game (RCG/Hagler Bailly, 1995c).

A suite of laboratory bioassay studies conducted under site specific conditions determined that copper and cobalt are acutely lethal to trout at concentrations less than those measured in the Panther Creek drainage; that copper concentrations lower than those measured in the Panther Creek drainage caused significantly reduced growth in rainbow trout fry; that copper bioaccumulated in rainbow trout fry at concentrations lower than those measured in the Panther Creek drainage; and that rainbow trout fry avoided copper concentrations lower than those measured in the Panther Creek drainage (RCG/Hagler Bailly, 1995d). Overall, the studies showed that salmonids in the Panther Creek drainage are injured by hazardous substances released from the Blackbird Mine site. Copper concentrations in Blackbird, Big Deer, and Panther Creeks continually exceeded concentrations shown in the toxicity studies to cause harmful effects.

Releases from Blackbird Mine contributed to the decline and, ultimately, the elimination of chinook salmon runs in Panther Creek. Historical data show a gradual reduction in the annual number of redds[6] in the upper Salmon River basin beginning in the early 1960s due to the effects of dam construction on the main stem of the Columbia and Snake River, loss and degradation of habitat, and other mortality factors. However, there are creeks in the basin that have redd and spawning activity. By contrast, chinook salmon redd counts in Panther Creek plummeted to zero in 1962 (RCG/Hagler Bailly, 1995c).

Historically, Panther Creek, one of the larger tributaries in the upper Salmon River system, supported substantial numbers of spring and summer chinook salmon with runs estimated at approximately 2,000 spawners annually (Idaho Department of Fish and Game, 1992). Although downstream impacts, including dams, ocean harvest, disease and predation, and habitat loss, reduced adult salmon returns to all parts of the Snake River basin, the reduction in Panther Creek salmon populations exceeded the expected loss from the generalized downstream effects. Based on the habitat conditions in Panther Creek (aside from degradation related to releases of hazardous substances from mining operations), and chinook salmon populations in other basin streams, the trustees determined that if water quality were not impaired, Panther Creek and its tributaries could support runs of 200 adult chinook salmon annually with associated annual production of 250,000 smolts (RCG/Hagler Bailly, 1995c).

The loss of chinook salmon in Panther Creek also represents a loss in ecosystem services. Most Salmon River basin streams are relatively nutrient poor. The return of salmon and their death after spawning are an integral part of the natural cycle, returning nutrients from the ocean into the headwaters of streams. Salmon carcasses support

[6] A redd is a nest developed in the gravel for salmon egg laying; the number of redds in a river is directly related to the number of spawning salmon in a river.

populations of a variety of mammals and birds. In addition, as the carcasses decompose, they provide a nutrient base for the stream, stimulating primary production, promoting growth of aquatic plants, macroinvertebrates, small fish, etc., and providing energy for the stream to support another generation of salmon.

Most Salmon River basin streams also support populations of the anadromous steelhead and it is likely that Panther Creek also had a substantial run that was eliminated due to the release of hazardous substances. Steelhead spawn during a time of year that makes redd counts impractical (high, turbid water) and no historical record of their population or documentation of loss was available upon which to base an injury estimate. Intensive efforts to reintroduce steelhead into Panther Creek in the 1970s and 1980s failed as a result of poor water quality (Petrosky and Holubetz, 1985). In 1997, the Snake River basin steelhead was listed as a threatened species under the Endangered Species Act (62 FR 43974, August 18, 1997).

In addition to biological injury and ecological service losses, releases from the mine also resulted in losses to human services. Panther Creek is one of the more accessible streams in Lemhi County, and once provided recreational opportunities including fishing, birding, and picnicking. Panther Creek was closed to salmon fishing in 1957 to preserve the remaining run (Welsh et al., 1965); salmon fishing has been closed in Idaho since 1977. Moreover, Panther Creek is a stream that has supported subsistence fishing for Native American Tribes. The Native Americans of the region depended on the fish resource as a food, barter, and religious base for their culture (Lahren, 1997 and HMS Associates, 1994). The injury to chinook salmon and the associated loss in ecological and human services was a primary concern to the trustees since salmon populations in the Snake River system had dropped to precarious levels.

C. Restoration Alternatives

Before undertaking primary and compensatory restoration of biological resources and services in Panther Creek, water quality in Panther Creek must be restored. Pursuant to the settlement agreement, EPA is overseeing cleanup at the site including actions necessary to restore water quality. The trustees planned primary and compensatory restoration based on the assumption that remedial action overseen by EPA would restore water quality by the year 2005.

The trustees selected naturally spawning spring/summer chinook salmon as both the metric for scaling primary and compensatory restoration, even though injury occurred to other fish species and ecosystem components in the Panther Creek drainage. Trustees chose this metric as an indicator of restoration success on the assumption of a high degree of correlation between salmon vitality and overall ecosystem health so that as the salmon population is restored, other resources would be restored as well. In fact, these other resources would recover on their own shortly after water quality restoration; salmon would not. Spring/summer chinook salmon was also an important restoration target because Salmon River chinook salmon was listed as a threatened species under the Endangered Species Act in 1992 (57 FR 14563, April 22, 1992).

The trustees proposed a suite of projects based on chinook salmon restoration in order to bring the service flow back to baseline and to compensate for interim lost services.[7] The projects fell into two categories: re-introduction of naturally spawning salmon into Panther Creek, and smolt survival activities to increase the survival rate of smolts within the creek. These interrelated actions were designed to ensure success of the overall restoration. Any one action would not be as successful performed independently of the other projects, i.e., the in-stream work to improve smolt survival increases the effectiveness of the hatchery and vice versa.[8] Both categories of projects affect recovery to baseline and compensatory restoration, thus primary and compensatory restoration actions were integrated.

1) Smolt Re-introduction

The trustees considered both artificial propagation and natural re-introduction strategies; they decided that outplanting of artificially propagated fish was necessary because natural straying was not likely to re-seed the habitat within an acceptable time frame.[9] The plan to restore naturally spawning salmon requires (1) construction of an adult fish trap on Panther Creek; (2) an expansion of an existing hatchery; and (3) construction of acclimation ponds on Panther Creek. For the first few years, natural migrating adults from a selected donor drainage would be trapped and transported to a hatchery for spawning, egg incubation, hatching, and rearing to the pre-smolt lifestage. The pre-smolts would then be transported to the Panther Creek system and placed in the acclimation pond for grow-out and smolting. The pond would be opened in the spring and smolts allowed to outmigrate into Panther Creek. Adult salmon are expected to return to Panther Creek 2 to 3 years after smolts are released. At that time, half of the returning adult fish would be trapped in the Panther Creek fish weir and transported to the hatchery for spawning, egg incubation, and rearing. The remaining half would be allowed to migrate upstream to spawn naturally. The process of trapping and transporting 50 percent of the adults to the hatchery would continue until the number of returning

[7] For the purpose of the settlement discussion, interim loss was calculated from 1980, the year CERCLA was enacted. We present the compensatory restoration component based on the settlement discussion.

[8] Smolt re-introduction, by itself, could restore salmon to their baseline level but not as quickly or cost effectively as when coordinated with smolt survival activities. Smolt survival activities alone could not restore salmon to baseline levels within any reasonable time frame.

[9] Without hatchery re-introduction, baseline would not be restored until at least 2150 due to the small stray rate of salmon into the Panther Creek basin. Salmon, by instinct, return to the stream where they were reared to spawn. Because salmon were eliminated from Panther Creek, few salmon would return to Panther Creek naturally to reproduce and repopulate the stream. Only the salmon that strayed from their native streams would begin to restore populations in Panther Creek.

adults reaches baseline conditions (projected in 2021).[10]

2) Smolt Survival Concepts

The second category of restoration action entailed increasing the number of healthy smolts leaving Panther Creek. A number of concepts were considered and developed in order to restore chinook salmon in the Panther Creek drainage. The final measures included: channel meander reconstruction, riparian corridor fencing, and construction of off-channel rearing habitat. These actions were expected to increase the number of smolts in Panther Creek by improving spawning and rearing habitat. Restoring the channel to its natural meander would increase available spawning and rearing habitat by decreasing channel gradients and velocities and increasing the length of the channel. Riparian corridor fencing would restore streambank stability, riparian vegetation, and fish habitat in areas that are affected by livestock grazing. Off-channel rearing ponds can be screened to keep out larger fish and protect juveniles. These measures represented those judged most biologically beneficial and cost effective for restoration.

Figure 2 demonstrates the interaction between the restoration alternatives and the life stages of chinook salmon. The goal is to increase the number of adult spawners returning to Panther Creek. The smolt re-introduction plan increases the number of pre-smolts in Panther Creek, which subsequently increases the number of smolts. By improving rearing and spawning habitat, the smolt survival actions increase the chance of smolt survival in Panther Creek, thereby increasing the number of smolts that outmigrate. The greater the number of smolts and the greater the number of smolts that outmigrate, the greater is the number of adult spawners that return to Panther Creek.

The strategies to supplement recovery to baseline and to compensate for interim losses consisted of measures both within and outside of the Panther Creek drainage.[11] The trustees preferred restoration within the drainage as a closer replacement to the lost resources and services, however, the lack of available land limited options. In order to fully compensate the public for interim lost resources and services, the trustees included restoration projects outside of the Panther Creek drainage.

D. Scaling

The trustees' objective was to determine the scale and composition of the restoration actions in order to (1) restore 200 naturally spawning salmon in Panther Creek annually; and (2) compensate the public for interim losses from 1980 until recovery to baseline. The scaling discussion includes both primary and compensatory action since

[10] The smolt re-introduction plan was formulated given the best available information and technology during the time of the damage assessment. The re-introduction plan in Panther Creek is expected to begin after the year 2000. Should technology or circumstances change prior to plan implementation, the trustees may revisit and revise the smolt re-introduction plan.

[11] Measures outside the Panther Creek drainage provided compensatory restoration; they are independent of primary restoration within Panther Creek.

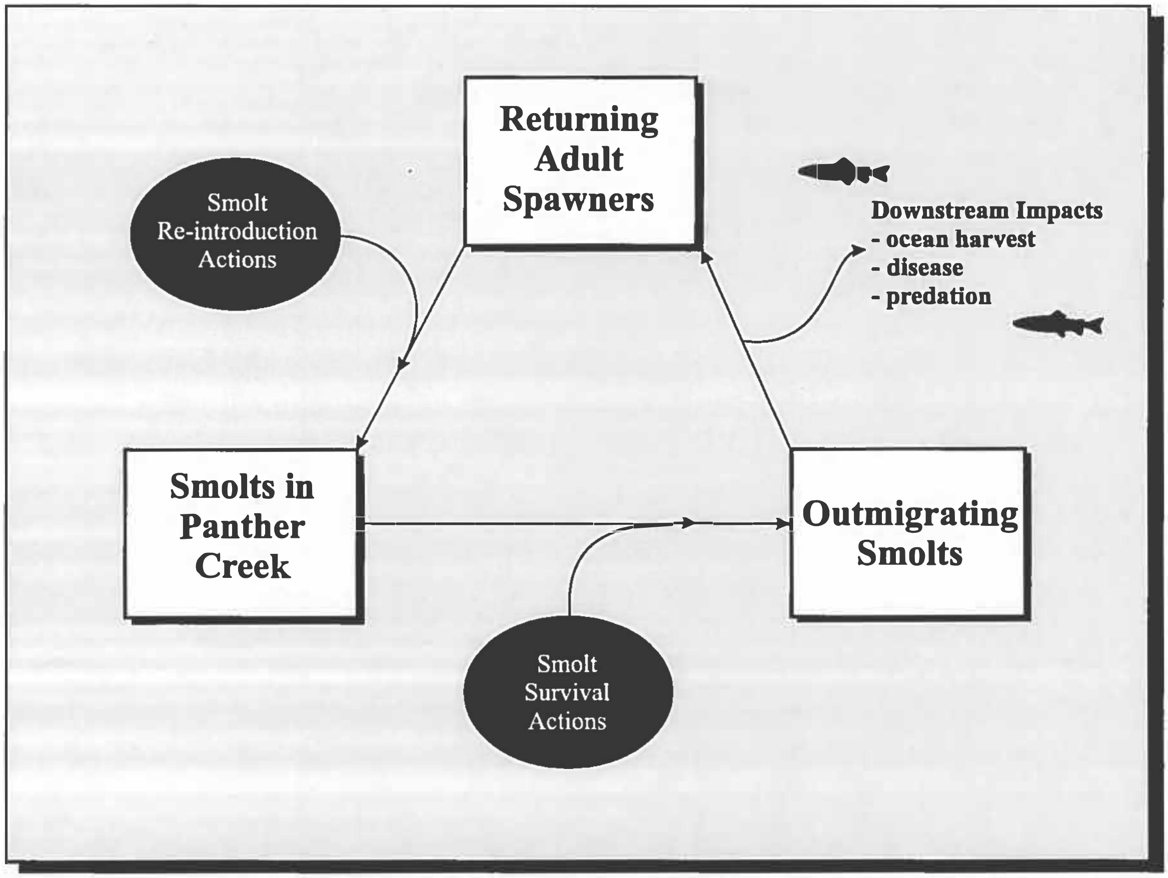

Figure 2. Salmon Life Stages and the Effect of Restoration on Returning Adult Spawners

the primary and compensatory actions were integrated.

Based on the possible metrics and the available restoration projects, the trustees selected the service-to-service scaling approach for determining the scale of compensatory restoration action. First, the trustees identified naturally spawning chinook salmon as the best metric to capture the level of services lost due to the injury, the level of services provided by the restoration projects, and the overall health of Panther Creek. The occurrence of salmon captures the level of injury and restored services since the conditions necessary for salmon vitality (good water quality; adequate migration, spawning, and rearing habitat) are also necessary to support steelhead, resident fishes, and streambed fauna and other services lost in the Panther Creek drainage. In contrast, an alternative resource metric (e.g. aufwuchs) would not capture all of the lost and restored services since salmon recovery does not automatically follow restoration of another Panther Creek resource. Because of their fidelity to natal streams and low straying rates; once lost from a drainage, the anadromous chinook salmon will only recover (in a reasonable time frame) through targeted restoration.

The metric also identified differences in the quality of services provided by the injury and replacement resources. Naturally spawning chinook salmon was the proposed metric to capture the quality and value of wild chinook salmon. Qualitative research revealed the public's preferences for wild relative to hatchery chinook salmon. The participants preferred wild salmon to hatchery reared salmon given the viability and genetic diversity of wild stocks. However, faced with a loss in wild stocks, participants considered a run restoration scenario of the type proposed by the trustees, using a hatchery-assisted program to rear wild donor stocks from an adjacent drainage, to be a close substitute to wild stocks. As a result, the trustees determined the salmon to be restored by the selected restoration method and wild salmon to be of comparable value.

The service-to-service approach to scaling is also appropriate since the changes in resources and services are sufficiently small so that the value per unit of service is independent of the changes in the stock of resources, and the scope of the market is the same for injury and replacement resources. The restoration plan calls for the return of 200 chinook salmon annually which is small relative to the current population of Snake River spring/summer chinook salmon.[12] The metric and the scope of the market suggest that the values of the lost and restored services are of comparable value. Thus, the choice of the service-to-service scaling approach is appropriate. For this case, the service-to-service approach was also more time and cost effective than the valuation approach.

The appropriate mix and scale of restoration actions was estimated through a salmon life cycle model that projects adult returns and smolt outmigrations in Panther Creek as a function of the restoration actions (R2 Resource Consultants, 1995). The trustees employed the model to evaluate the effects of restoration on the salmon population. The model tracks adult returns to baseline and the cumulative losses from 1980 for estimating interim losses; a discount factor of three percent was applied to the calculation of interim losses and restoration gains.[13] The trustees identified the most feasible and cost effective restoration actions to return the salmon population to baseline and to equate the present discounted quantity of restored salmon years with the present discounted quantity of salmon years lost due to the injury. Figure 3 illustrates the scaling concept based on the final settlement between trustees and the responsible parties.

The metric for the injured resources and services is the number of adult chinook salmon returning to spawn annually. Baseline is the level of salmon population (assumed to be constant and equal to 200 adult spawners) given the current downstream impediments and current on-site conditions but for the discharge. Prior to restoration, the level of services is zero. Services begin to recover with the biological restoration activities; the life cycle model predicts the recovery trajectory. Initiation of salmon recovery and restoration to baseline are expected to occur in 2005 and 2021, respectively.

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[12] Within the last ten years, many millions of dollars have been spent on salmon recovery in the Columbia River Basin. Because of the Endangered Species Act listing, a recovery plan has been developed, and significant improvements in conditions adversely affecting chinook salmon populations are expected. As a result, the trustees assumed downstream conditions would improve and there would no be further reductions in the Snake River salmon population, triggering changes in the value per restored salmon.

[13] NOAA typically recommends applying a three percent rate for discounting interim losses and gains. See *Scaling Compensatory Restoration Actions, Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990*, National Oceanic and Atmospheric Administration, Damage Assessment and Restoration Program, 1997.

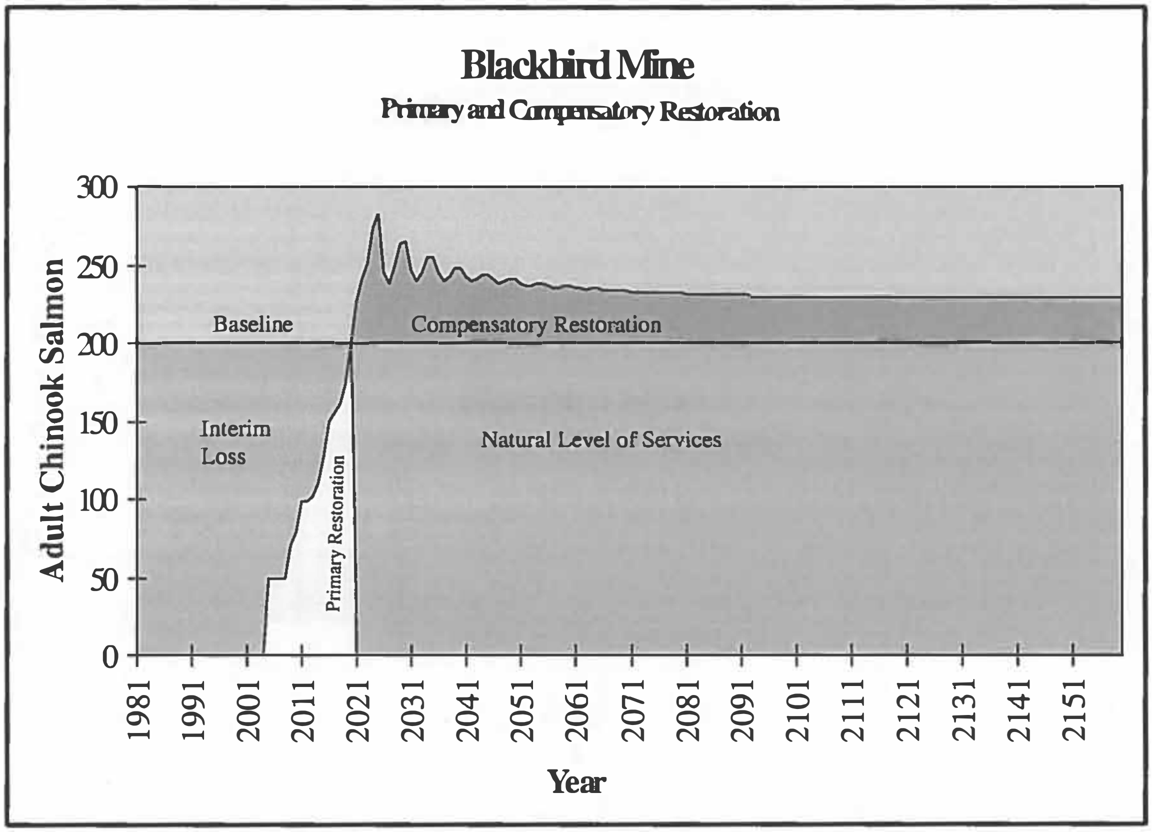

Figure 3. Primary and Compensatory Restoration Scaling Components within Panther Creek.

Total interim loss of services due to the Blackbird Mine is identified in the diagram.

With restoration targeted for Panther Creek, compensatory actions were designed to enhance the productivity of the site beyond the baseline level of services. These compensatory actions were also intended to accelerate the rate of recovery to baseline. Thus, the compensatory services begin to accumulate in 2021, the same time that baseline is restored. Due to the limited possibilities for work within Panther Creek, compensatory restoration included out-of-basin action. These measures provided the equivalent of naturally spawning chinook salmon and were credited against the interim loss of resources and services within Panther Creek.

E. Outcomes

The Consent Decree, among other things, requires the Responsible Parties (RP) to: remediate the mine site and water quality in accordance with the cleanup program to be selected by EPA – the water quality objectives are designed to allow Panther Creek to support all life stages of salmonids; implement a Biological Restoration and Compensation Plan (BRCP) to restore, enhance, and create anadromous salmonid habitat in site-impacted and out-of-basin streams; fund trustee oversight of BRCP implementation; and make cash payments for trustees' past damage assessment and response costs.

Major components of the salmon restoration plan include:

- Restore chinook salmon through rearing the progeny of a suitable donor stock in an existing Idaho hatchery for release into Panther Creek; construct a fish barrier/trap and acclimation ponds to capture returning adults and to imprint juveniles.

- Create 2.0 acres of off-channel habitat in Panther Creek to improve juvenile rearing conditions (100 year project life).

- Realign approximately 1.2 miles of Panther Creek that has been channelized and straightened to conform to its natural meander pattern; and construct riparian corridor fencing to exclude livestock (50 year project life).

- Fence 2.0 miles of private land along Panther Creek to exclude livestock and allow regeneration of riparian habitat, improving spawning and rearing conditions for anadromous salmonids (50 year project life).

- Fence 8.0 miles of private lands along other Salmon River basin tributaries to exclude livestock and allow regeneration of riparian habitat, improving spawning and rearing conditions for anadromous salmonids (50 year project life).

Under the terms of the settlement, the RP has agreed to carry out the salmon restoration plan with trustee oversight. Implementation will proceed over a period of years, with measures in Panther Creek timed to coincide with water quality remediation (expected in 2005). A trustee council, consisting of one representative each from NOAA (National Marine Fisheries Service), U.S. Forest Service, and the State of Idaho, will make all decisions regarding implementation. Trustees estimate that the total cost of salmon restoration and trustee oversight will be $9.0 million, excluding damage assessment costs.

The trustees included several provisions in the consent decree to force RP compliance with the restoration plan. The RP is subject to stipulated penalties (fines) for each day it fails to complete a deliverable or fails to produce a deliverable of acceptable quality. It also must pay liquidated damages as compensation for interim loss damages in the event of delays in the biological restoration plan. The trustees analyzed scenarios to determine the damage associated with different delays; these damages were calculated using the same service-to-service framework that was employed for the original compensation calculation. If water quality does not meet specified standards any time after January 1, 2002, the RP must take additional action, with the approval of trustees and in consultation with EPA, to achieve water quality criteria.

F. Conclusions

Service-to-service scaling is one method for determining the scale of restoration necessary to compensate the public for natural resource injuries. The service-to-service method should be applied only when the injured resources and services are the same type, quality, and of comparable value to replacement resources and services obtained through restoration actions. Then, the appropriate scale of replacement resources and services is determined by equating the quantity of discounted services lost and the quantity of discounted replacement services using a carefully selected metric.

The Blackbird Mine case illustrates the conditions under which the service-to-service method applies and the benefits of the approach. The trustees selected naturally spawning spring/summer chinook salmon as the metric to represent service losses at the injury site and service gains at the restoration sites. Further, the metric captured quality differences between the restored hatchery salmon and the injured wild salmon. Given the metric and the fact that the supply and demand conditions were similar for the injury and replacement resources, the service-to-service method was appropriate for determining the scale of restoration. In addition to being a timely and cost effective scaling approach in this case, the service-to-service method is a mechanism to provide direct, in-kind restoration in Panther Creek.

III. REFERENCES

Baldwin, 1977. Water Resource Problems Related to Mining in the Blackbird Mining District, Idaho. M.S. Thesis, University of Idaho, Moscow, Idaho.

Bechtel, 1986. Habitat Rehabilitation-Panther Creek Idaho. Bonneville Power Administration, Division of Fish and Wildlife, Project No. 84-29. Portland, Oregon.

Crist, L., 1990. Aquatic Biology Technical Report for the Beartrack EIS, Bio/West Inc., Logan, UT. Submitted to ACZ Inc., Steamboat Springs, CO, prepared for the Salmon National Forest, Salmon, ID *in* Mebane, C. 1994. Preliminary Natural Resource Survey, Blackbird Mine, Lemhi County, ID. Coastal Resource Coordination Branch, Region 10, Seattle, WA.

ERT and P.T. Davies, 1981. Water Quality Technical Report for the Blackbird Project. Prepared by P.H. Davies and Environmental Research & Technology, Fort Collins, CO. Submitted to USDA Forest Service, Salmon National Forest.

Hassemer, P.F., 1993. Salmon Spawning Ground Surveys, 1989-1992. Project F-73-R-15, Pacific Salmon Treaty Program. Idaho Department of Fish and Game, Boise, ID *in* RCG/Hagler Bailly, 1995c.

HMS Associates, Inc./The Arrowrock Group, 1994. Historical Analysis of Anadromous Fish Runs in Napias Creek. Report Prepared for Holland and Hart, Boise, ID.

Idaho Department of Fish and Game, 1992. Anadromous Fish Management Plan 1992-1996. Boise, Idaho.

Jones, C.A. and K.A. Pease, 1997. Restoration-based Measures of Compensation in Natural Resource Liability Statutes, Contemporary Economic Policy Vol. XV, Number 4, 111-122.

Lahren, S.L., 1997. Historical and Ethnographic Analysis of Salmon Presence in the Leesburg Basin, Lemhi County, Idaho. Report prepared for Meridian Gold Company, Salmon, ID.

Petrosky, C.E. and T.B. Holubetz, 1985. Idaho Habitat Evaluation of Off-Site Mitigation Record, Annual Report 1984 (pp. 1-207). Prepared by Idaho Department of Fish and Game for U.S. Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife, Portland, OR *in* RCG/Hagler Bailly, 1995c.

R2 Resource Consultants, Inc., 1995. Panther Creek Biological Restoration and Compensation Program. Report prepared for National Oceanic and Atmospheric Administration.

RCG/Hagler Bailly, 1994. 1993 Spring Surface Water Resource Injury Assessment, Blackbird Mine Site NRDA. Prepared by D. Beltman, D. Cacela, J. Lipton, A. Maest, and J. Schardt for State of Idaho and National Oceanic and Atmospheric Administration.

RCG/Hagler Bailly and Colorado State University, 1994. Benthic Macroinvertebrate Injury Studies, Blackbird Mine, Idaho. Prepared by D. Beltman, J. Lipton, and D. Cacela, RCG/Hagler Bailly, and W. Clements, Colorado State University, for the State of Idaho.

RCG/Hagler Bailly, 1995a. Spring 1994 Surface Water Injury Assessment, Blackbird Mine Site NRDA. Prepared by D. Beltman, D. Cacela, J. Holmes, K. LeJeune, J. Lipton, A. Maest, and T. Podrabsky for State of Idaho and National Oceanic and Atmospheric Administration.

RCG/Hagler Bailly, 1995b. Fish Population Survey Panther Creek, Idaho. Prepared by K. LeJeune, J. Lipton, W. Walsh, and D. Cacela, for State of Idaho and National Oceanic and Atmospheric Administration.

RCG/Hagler Bailly, 1995c. Injury Quantification to Fishery Resources: Literature Review, Blackbird Mine Site NRDA. Prepared by K. LeJeune, J. Lipton, and W. Walsh for State of Idaho and National Oceanic and Atmospheric Administration.

RCG/Hagler Bailly, 1995d. Fisheries Toxicity Injury Studies Blackbird Mine Site, Idaho. Prepared by J. Mary, J. Lipton, and D. Cacela for National Oceanic and Atmospheric Administration.

USDA Forest Service, 1979. Water Quality in an Idaho Stream Degraded by Acid Mine Waters. Prepared by W.S. Plats, S.B. Martin, and E.R.J. Primbs. General Technical Report INT-67.

USDA Forest Service, 1991. Preliminary Assessment Site Investigation: Blackbird Cobalt-Copper Project, Lemhi County, ID. Prepared by Salmon National Forest, Region 4, USDA Forest Service.

USDA Forest Service, 1993. Ongoing and Proposed Projects; Review and Cumulative Effects Analysis - Panther Creek Sub-basin Salmon National Forest. Prepared by K. Forester, E. Rieffenberger, D. Baird, C. Groll, and J.E. Burns, Salmon National Forest.

Welsh, T.L., S.V. Gebhards, J.E. Metsker, and R.V. Corning, 1965. Inventory of Idaho Streams Containing Anadromous Fish Including Recommendations for Improving Production of Salmon and Steelhead. Part I. Snake, Salmon, Weiser, Payette, and Boise River Drainages. Idaho Department of Fish and Game Department.