# The Bull Trout Recovery Monitoring and Evaluation Technical Group (RMEG)

The RMEG is a multi-agency body chaired by the U.S. Fish and Wildlife Service fisheries technical staff and independently facilitated. The group consists of 14 members representing a balance of skills in population dynamics, char biology, field studies, biometrics, and experimental design. The RMEG provides guidance and support to bull trout recovery efforts in three primary areas: 1) monitoring designs, 2) specific monitoring techniques, and 3) analytical methods. Nine workshops (March 10/11, July 12/13, December 16/17 of 2004, June 27/28 of 2005, January 3/4, June 6/7 of 2006, and January 29/30, June 5/6, Oct 23-25 of 2007) have been held to develop ideas in these areas. These workshops have served to synthesize and stimulate ongoing work by RMEG members. This document summarizes key RMEG activities to date.

## Development of Monitoring and Evaluation Strategies

Four "recovery objectives" have been established for bull trout under the USFWS draft Bull Trout Recovery Plan:

1. Maintain **current distribution** of bull trout within bull trout Core Areas
2. Maintain **stable or increasing trend in abundance**
3. Restore and maintain **suitable habitat conditions** for all bull trout life history stages
4. Conserve bull trout **genetic diversity** and provide opportunity for genetic exchange

Development of broad scale monitoring and evaluation strategies is essential for evaluating progress on these recovery objectives, assessing changing status and evaluating the effectiveness of specific recovery actions. The RMEG is focused on addressing four key components critical to evaluating Recovery Plan objectives: distribution, connectivity, abundance and trends in abundance. There are, however, serious challenges in determining how, when and where to best monitor bull trout populations and their habitats, as well as in establishing analytical approaches for evaluation that are statistically sound and rigorous.

## Distribution

### Challenges

A population is defined as a reproductive group of individuals that share a common gene pool. Unfortunately, information on bull trout population structure is lacking for many watersheds. This has created problems and inconsistencies in the identification of local populations as part of the Bull Trout Recovery Plan process. Variation in approaches has resulted in bull trout in individual tributaries within recovery units often being designated as separate local populations (splitting), while in other recovery units there has been a tendency to lump tributaries together into a single local population. The absence of a consistently defined population sampling unit makes it difficult currently to reliably track changes in distribution. In order to improve evaluations of bull trout distribution there are six principal questions that the RMEG must address:

1. How to define metrics that will be used to judge the recovery objective of 'maintain current distribution'
2. How to consistently identify sampling units for monitoring distribution?
3. How to develop a sampling design to determine if distributions are changing?
4. What monitoring protocols to use at each sampling unit to determine bull trout presence?

5. What level of power (statistical reliability in conclusions) will be acceptable for concluding distributions are contracting, stable or expanding?
6. What combinations of sampling designs and monitoring protocols meet acceptable levels of statistical reliability?

**RMEG approaches**

The RMEG has adopted a process whereby the geographical boundaries for potential local populations can be represented by bull trout "patches" - contiguous areas within a stream network where spawning and early juvenile rearing could occur and potentially support a local population. These patches are intended to provide the basis for a consistent sampling unit that can be used to track changes in the distribution of bull trout populations. A two stage filtering process is being used by the RMEG to identify bull trout patches: 1) identification of 'potential' patches for bull trout (which may not be currently occupied for various reasons), and 2) identification of 'realized' bull trout patches which are currently occupied based on both existing information and new sampling. The contrast of 'potential' and 'realized' bull trout patches will additionally relate to an evaluation of connectivity, another important element in the recovery process.

The RMEG has developed novel GIS-based approaches for generating broad-level delineations of bull trout patches based on water temperature, elevation and catchment size criteria. The RMEG is currently working to delineate bull trout patches and create patch sampling strategies for bull trout distribution within a series of test watersheds throughout the Columbia River Basin. For each of these test cases the RMEG is working in partnership with regional biologists who are assisting in refining/adapting the RMEG's broad patch delineations as necessary to account for localized conditions.

Measures of changing distribution will first require an evaluation of the presence of bull trout within and among patches. The RMEG has also developed simulation approaches to determine which sampling designs could most reliably detect changes in patch occupancy. These models are intended to evaluate a range of tradeoffs across potential sampling methods, sampling effort, sample sizes, effect sizes, costs and acceptable levels of statistical reliability. The RMEG is also using test watersheds to evaluate whether EPA's General Random-Tessellation Stratified (GRTS) sampling approach can provide the base design for bull trout patch monitoring.

## Connectivity

**Challenges**

Connectivity refers to the maintenance of suitable stream conditions that allow bull trout to move freely upstream and downstream with habitat linkages that connect to other habitat areas. Two of the Bull Trout Recovery Plan objectives relate to connectivity: 1) conserve genetic diversity and provide opportunity for genetic exchange; and 2) restore and maintain suitable habitat conditions for all life history stages and strategies. These objectives imply that measures/monitoring of connectivity must then be considered from two distinct perspectives: 1) connectivity among local populations (i.e., effective dispersal) and 2) connectivity to the migratory corridor associated with each local population (i.e., unrestricted migration opportunities and the full expression of life history strategies).

**RMEG approaches**

The RMEG is evaluating methods that could be used to quantify three aspects of bull trout habitat that relate to connectivity: 1) barriers (thermal/physical); 2) distance between bull trout "patches" (dispersal); 3) distance to migratory rearing areas (expression of life history). The RMEG have been evaluating the ability to quantify connectivity from GIS overlays of natural and human constructed movement barriers,

and the geographic extents of bull trout patch delineations (local populations).This information is being used in test watersheds to construct a Connectivity Index that provides a metric for quantifying historical and current connectivity networks within a core area, and that can be used to predict or track increasing or decreasing connectivity as a result of future restoration actions. RMEG's Connectivity Index will additionally be used for evaluating the role of connectivity in the long term persistence of occupied bull trout patches. The RMEG intends to pursue further evaluation of connectivity through population genetics and measures of population structure. Simulation models will be developed to determine how much connectivity is required to maintain bull trout populations, and how often gene flow events are necessary to maintain population structure.

## Abundance and Trends in Abundance

### Challenges

A variety of sampling techniques can potentially be employed for monitoring bull trout abundance; all, however, have some degree of uncertainty around the obtained abundance estimates. For example, redd counts represent a widespread and relatively inexpensive technique for estimating spawning adult abundance. However, redd counts are frequently limited by some combination of strong observer variability, redd superimposition, poor delineation of test digs and redd, and substrate. Trapping of adult bull trout at weir or fish ladders can provide direct information on adults but is dependent on efficient, continuous trap operation/inspection and also fails to account for resident adults that do not migrate below the traps. Snorkel counts can provide a relatively, inexpensive, non-invasive technique for estimating abundance by bull trout size class but has been shown to consistently underestimate abundance and have low precision due to the frequent low densities and high spatial variability of bull trout populations. Additionally, snorkeling may not be feasible in small, shallow streams and can be ineffective at cold temperatures. Electrofishing is not generally used for monitoring adult bull trout abundance due to the perceived risk of injury or mortality to larger fish. There are benefits to electrofishing, however, in that important monitoring data can be obtained by having fish in-hand (e.g., precise lengths, sex, maturity, genetics). The higher sampling efficiency of single-pass electrofishing also provides a less biased estimate of abundance than snorkeling. Similar to snorkeling, however, single-pass electrofishing appears to consistently underestimate abundance, and it has limited feasibility in large rivers (e.g., inability to block net). Electrofishing depletion estimates (i.e., multiple-pass electroshocking) provide a more unbiased and precise estimate of true population abundance than single-pass estimates of abundance, but require a much greater commitment of personnel and time presenting a potential limitation for many monitoring programs. Mark-recapture techniques provide arguably the most accurate technique of estimating bull trout abundance and trend, and simultaneously provide information on fish vital rates, movement patterns and population structure. However, mark-recapture is also typically the most expensive monitoring technique and requires a high degree of effort and handling of fish.

For bull trout recovery to be accepted, numbers of spawning fish in core areas must demonstrate a stable or increasing trend for two generations at or above target recovery abundance levels. However, determining bull trout abundance presents distinctive sampling challenges. Within a population or core area bull trout can exhibit different complex life-history strategies (resident, migratory), may occupy a diversity of habitats, are cryptic in their behaviour and often occur at naturally low densities. Estimates of adult abundance usually provide more complete information (than juveniles) about population health because adults have successfully transitioned through all life-stages and the habitats that support each life stage. Therefore, given that the recovery criteria for abundance are based on reproductive adults and the difficulties in extrapolating between juvenile and adult abundance, the RMEG has only considered sampling techniques and survey design applicable to estimating adult abundance. It is likely that different attributes of adult abundance will need to be measured using different methods in different regions, accounting for the variation in bull trout life history, habitat type, logistical considerations and the resources available.

**RMEG approaches**

The RMEG is in the early stages of evaluating the difficulties associated with reliably estimating bull trout absolute abundance or changes in abundance. Current RMEG efforts have focused on identifying the sampling challenges associated with estimating abundance for bull trout, synthesizing lessons learned with regard to different sampling techniques and approaches, and developing an annotated flow chart summarizing pros and cons of each technique for addressing different abundance metrics.

## Intended RMEG Synthesis:

- Determine connectivity between bull trout Core Areas and "patches" (using GIS approaches/supplemented)
- Determine bull trout distribution for a subset of Core Area patches
- Determine bull trout abundance trends for a smaller subset of patches
- Determine absolute abundance of bull trout for a still smaller subset of patches
- If stratified subsampling conducted through statistically rigorous site selection methods, it should be possible to roll results up to higher spatial scales (i.e., Core Area, Recovery Unit and DPS) (Figure 1)

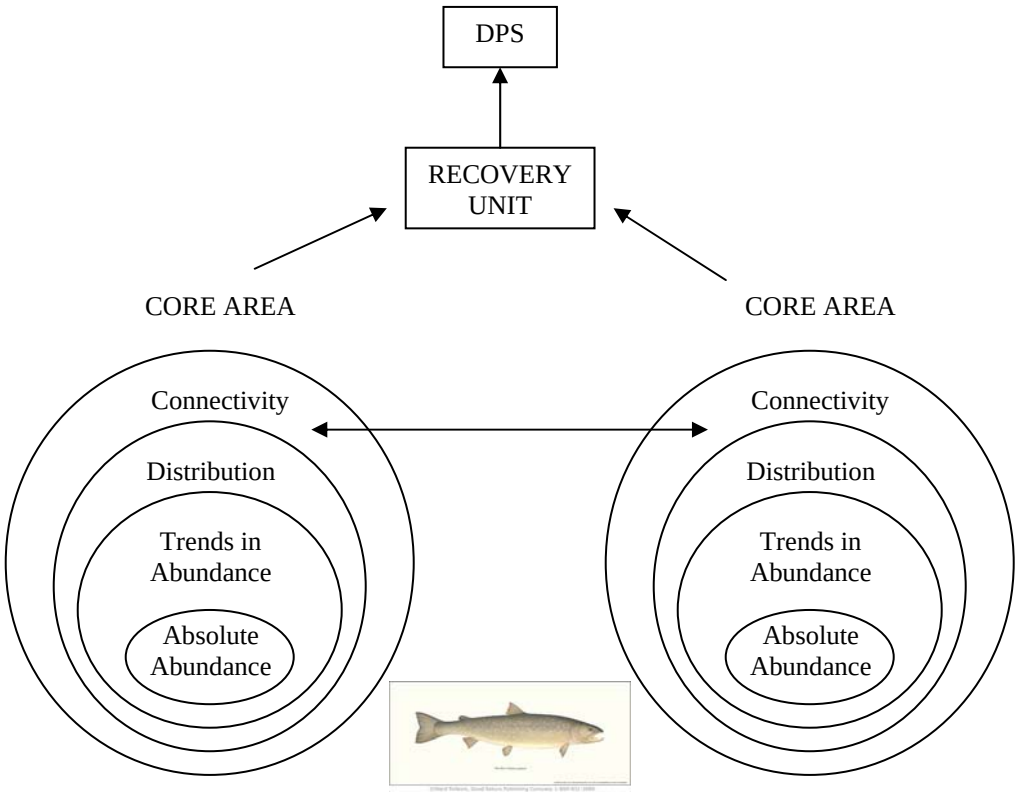


**Figure 1.** A proposed linking of the components of bull trout recovery monitoring into the larger Recovery Plan framework.

### RMEG Workshop Reports

**Marmorek, D.R. and M. Porter.** 2004. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 1 (March 10-11, 2004) - USFWS Regional Office, Portland, OR - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 52 pp.

http://www.cbfwa.org/Committees/CSMEP/Meetings/2004_0609/BullTrout_workshop_reportMarch2004.doc

**Porter M. and D.R. Marmorek.** 2004. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 2 (July 12 -13, 2004) – Boise Aquatic Sciences Lab, US Forest Service, Boise, ID - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 75 pp.
http://www.cbfwa.org/Committees/CSMEP/Documents/Reports/2004_0913BullTroutWorkshop.pdf

**Porter M. and D.R. Marmorek.** 2004. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 3 (December 16-17, 2004) – US Forest Service Regional Office, Portland OR - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service. 123 pp.

**Porter M. and D.R. Marmorek.** 2005. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 4 (June 27-28, 2005) – USFWS Regional Office, Portland, OR - Workshop Report. (Report in prep) by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 100 pp.

**Porter M. and D.R. Marmorek.** 2006. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 5 (January 3-4, 2006) – USFWS Regional Office, 911 NE 11th Ave., Portland, Oregon - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 98 pp.

**Porter M. and D.R. Marmorek.** 2006 (draft). Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 6 (June 6-7, 2006) – Grouse Mountain Lodge, Whitefish, Montana - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 146 pp.

**Porter M. and D.R. Marmorek.** 2007. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 7 (January 29-30, 2007) – Edith Green Bldg., Portland, Oregon - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 141 pp.

**Porter M. and D.R. Marmorek.** 2007. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 8 (June 5-6, 2007) – USFWS Field Office, 1211 S.E. Cardinal Court, Suite 100 Vancouver, WA - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 133 pp.

**Porter, M. and D.R. Marmorek.** 2007. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 9 (October 23/24/25, 2007) – USFWS Field Office, 1211 S.E. Cardinal Court, Suite 100 Vancouver, WA - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 138 pp.