ISAB

Independent Scientific Advisory Board

for the Northwest Power and Conservation Council,
Columbia River Basin Indian Tribes,
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Memorandum (ISAB 2010-6)   **November 24, 2010**

To: Bruce Measure, Chair, Northwest Power and Conservation Council

From: Nancy Huntly, ISAB Chair

Subject: Review of the data and graphics for the Council's draft High Level Indicators' Progress Report (pamphlet) to Governors and Congress

Background

In the 2009 Columbia River Basin Fish and Wildlife Program, the Northwest Power and Conservation Council (Council) committed to adopt and periodically update high-level indicators (HLI) for the purpose of reporting program success and accomplishments to Congress, the region's governors, legislators, and citizens of the Northwest. High-level indicators will include biological, implementation, and management components. In December 2009, the Council adopted the following three questions that would be addressed in its first high level indicator report:

1) Are Columbia River Basin fish and wildlife abundant, diverse, productive, and spatially distributed, and sustainable?

2) Are mainstem hydropower dam operations meeting the Fish and Wildlife Program's survival and passage objectives?

3) Are Council Program actions coordinated within the Program and with other programs?

The Council's draft July 2010 Monitoring, Evaluation, Research and Reporting (MERR) Plan restates this commitment for the Council to communicate to Congress and governors on the Program's progress by using HLI. The MERR Plan further states that the Council will ask the Independent Scientific Advisory Board (ISAB) to assess the data used in reporting these HLI. This assessment will include verifying the caveats associated with the data to ensure that any constraints are properly conveyed.

On October 1, 2010, the Council asked the ISAB to assess whether the data gathered for the 2010 HLIs are being portrayed correctly with the relevant caveats in a September 2010 draft pamphlet titled, *High Level Indicators' Data and Graphics for Reporting on Fish and Wildlife Program Progress to Governors and Congress*. The ISAB and ISRP previously reviewed the Council's proposed HLIs (ISRP/ISAB 2009-2) and the draft MERR plan (ISAB/ISRP 2010-3). This review of the draft HLI report graphics and data, and associated caveats, is a logical extension to those earlier reviews.

The ISAB understands that the draft two-page pamphlet is not in final form, and the final pamphlet will integrate a map of the Columbia River and photos of habitat, fish, and wildlife with the data-oriented graphics. The ISAB further understands that this is the Council's first attempt to assemble these data from many sources into one place. The initial effort may bring to light questions about the ease of access to data, level of effort required to achieve consistency among data sources, and remaining data gaps. The primary sources for data in the HLI report are NOAA Fisheries, the Columbia Basin Fish and Wildlife Authority (CBFWA), Fish Passage Center and Bonneville Power Administration's Pisces database. The pamphlet was organized into three sections in order to address each of the three Council questions listed above.

In addition to asking for the ISAB's assessment of whether the HLI data are being portrayed correctly with the relevant caveats, the Council also asked for the ISAB's guidance on the following points:

- Are the data used for the HLIs appropriate? Are there some HLIs for which the data are so inappropriate that the Council should not report on that HLI at this time?
- Do the caveats allow the Council to use the HLI data even though the data are not the best the Council could desire for the HLI?
- Are the graphics easy to comprehend for non-scientists?
- Do the HLIs convey the Council's message that habitat is the base of the Program?
- Input on potential titles or catchy header. Staff have suggested these thus far:

  - Habitat is the heart of the Program
  - Providing Pathways for Populations or Providing Pathways for Fish and Wildlife
  - Upstream Indicators
  - Pathways to Success

The ISAB's review below begins with general observations on the HLI graphics, and then proceeds with comments organized by the three questions posed by the Council and addressed in the two page pamphlet.

A. General observations

The ISAB recognizes the challenges of designing a brief two-page pamphlet that provides succinct, meaningful visual answers to the three high level indicator questions posed by the Council. Encapsulating the progress of such a comprehensive and complex planning and management effort as the Fish and Wildlife Program into a pamphlet is a daunting task. An effective pamphlet will require a clear focus on the questions being asked, the use of the highest quality data from monitoring programs, the use of graphics that are easily understood by the audience, selection of the best indicators for answering the questions, and a clear indication of progress to date. The graphics must be carefully designed to convey meaning with maximum clarity, compactness, consistency, and impact. As always, identifying the best data and understanding and conveying its strengths, limitations, and qualifications pose challenges. The ISAB appreciates the opportunity to provide comments on the pamphlet content and graphics at this early stage of development.

Overall, the ISAB felt that the HLI graphics as drafted only partially answered the questions posed by the Council and were often in a form that would not be easily understood by the audience. We offer some suggestions below on how to improve the clarity, consistency, and impact of the graphics.

Overall comments relevant to all figures

The use of captions – Each graphic should be designed to illustrate a specific "take home message" that the Council wants to deliver. That message should be comprehensible without too much effort by the reader. While the content and importance of the graphics used in this draft pamphlet should be obvious to many readers, an interpretive figure caption above each figure would be very helpful in clarifying the take-home message. Without this additional text, the reader may wonder what message is being delivered.

The inclusion of reference or target levels for each metric – When appropriate, each graphic should have some reference point by which to judge the data presented with reference to the question addressed. It should be *possible* to draw a conclusion, or else the graphic is not meaningful. Thus, even if the Council prefers not to lead the reader to a particular interpretation about the graphic, the graphic should show the metric relative to a specific goal, past conditions, or long-term average.

The consistent and mnemonic use of colors – The ISAB notes that although the color in figures was used to improve the attractiveness of the presentation, color was not in all cases used effectively to convey information. For example, in the draft, hatchery fish are shown in green in the salmon abundance figure and wild fish are shown in green in the harvest figure. This sort of inconsistency causes confusion and reduces readability. There should be consistent use of colors throughout the document. Secondly, there should be mnemonic use of color throughout the document, i.e., the use of colors designed to be easily remembered and associated with particular items, issues or social patterns. For example, traffic signal colors might be used to

show trends. In depicting trends as increasing (i.e., a positive effect or improving relative to Plan objectives), one might use the color green. In depicting decreasing trends or deteriorating relative to plan objectives, one might use the color red. For stable or near target conditions, one might use the color yellow. Similarly, one might use blue for wild fish ("wild blue"), metallic silver for hatchery fish (metallic =technological), and unknown hatchery/wild origin maybe a blue/metallic hatched color. Consistent use of these mnemonic colors can more effectively convey information with the great economy needed in the pamphlet.

Standardization of figure types where possible – The pamphlet should attempt to standardize or minimize the type of graphs used to present data. The existing draft uses a variety of graph types, e.g., line charts, bar charts, stacking charts that may complicate the message. For example, lamprey and sturgeon abundance data are presented in different formats.

Documentation of data sources – The online version of the pamphlet should document data sources and how the datasets were derived, plus any caveats. The pamphlet should reference the online version.

Conveying a sense of change – Although the brief pamphlet must be limited in its content, the ISAB notes that an HLI report should give the reader a sense of the rapidly changing conditions in the Columbia River Basin (e.g., climate, invasive species, and so forth). The Columbia is facing a "no-analogue" future where the processes and species shaping habitats, populations, and communities are changing rapidly and in many cases to conditions with no natural precedent. Creating and maintaining resilience and adaptive capacity in fish and wildlife populations will depend on meeting many of the goals outlined in the Fish and Wildlife Program. This important issue should be emphasized in the HLI report. Managing and preserving diverse, productive, and resilient fish and wildlife populations and their habitats will become more complex in the future. An important strategy, in addition to the habitat focus, will be to remain open to new ideas, expand cooperation, and be flexible in actions.

B. Specific comments related to questions

HLI Report Question 1: Are Columbia River Basin fish and wildlife abundant, diverse, productive, spatially distributed, and sustainable?

Four charts are used to answer this complex question. However, the four charts only address abundance of lamprey (inconsistent index counts at four dams), abundance of white sturgeon (inconsistent dataset), abundance of anadromous salmonids in 2008, and harvests of hatchery and natural origin salmonids in 2007, 2008, and 2009. Spatial distribution information presented in the graphs is confounded by missing data in some years and locations. Where the graphic is designed to reveal trends in a metric, special care is needed to ensure that the metric is comparable across years, or else the graphic may be misleading. Often, as in the case of the white sturgeon (see comments below), a subset of the data that are consistently representative will reveal trends more reliably than will an inconsistently derived aggregate of all available

data. Only indirect information is provided on productivity (through abundance) and little or no information provided on diversity, spatial structure, and sustainability. No information is provided for wildlife as a group or individual species.

Salmon figures – The 2008 graphic showing abundance of hatchery, natural origin, and unknown origin salmonids is limited because it only shows data for one year. Unfortunately, there is no time series of basinwide salmonid abundance by hatchery versus natural origin. If the goal of the chart was to state that most salmonids in the Basin are from hatchery or unknown origin, as shown in the chart, then a graphic like this would be appropriate, assuming it contained a message telling the reader how to interpret the graph. This graph would have more utility if it is linked to the CBFWA dam count figures and it is used as an example of relative abundances of hatchery, natural origin, and unknown origin salmonids. The observation that the origin of many salmonids (hatchery *versus* natural) is unknown in the harvest and spawning escapement is an important message. Inaccurate estimates of natural salmon production can complicate evaluation of stock status of these wild populations that depend on habitat whereas hatchery reared juvenile fish use the river mainly as a corridor to the estuary and ocean. Greater use of mass marking techniques in hatcheries should help to improve stock origin information. The term "natural origin salmon" is preferred over "wild salmon" in the Columbia River Basin because hatchery strays are significant in some watersheds.

The take home message in the salmon and steelhead harvest chart is not obvious. Is it important to highlight the three harvest groups (commercial, tribes, sport), or hatchery versus natural origin fish in the harvests, or is there another objective in showing these data? The chart shows harvests during three years but this short time series does not tell the reader anything about the status of natural origin or hatchery salmon, productivity, spatial distribution, sustainability, or whether harvests by these groups is stable, increasing or decreasing. Furthermore, there is no identification of species or race of salmon. This type of graph will be more important in the future when a longer time series is available. The graph is an example of how an interpretive figure caption is needed to highlight what the Council wants the viewer to see in the graph.

ISRP/ISAB (2009-2) provided a number of suggestions to address the broad question of how to convey abundance, productivity diversity, and spatial structure. They suggested that the time series of fish abundance estimates at the Columbia River mouth, Bonneville Dam, Lower Granite Dam, and Priest Rapids Dam might be used to capture both trends in abundance and spatial distribution at key locations in the Basin (see Figures by CBFWA). The overall abundance trend in the CBFWA figures are easy for readers to interpret, but they do not attempt to separate natural origin versus hatchery salmonids because the data do not exist for most years. Stacking charts such as those in the draft are not ideal because trends for each species or race of salmon are difficult to follow, but the graphs do provide a quick view of overall trends in total salmonid abundance and the viewer can gain a sense of species composition.

Another suggestion by the ISRP/ISAB to depict diversity and spatial structure was a color-coded subbasin map or ESU map (see Fig. 1 below) to indicate status trends of key natural origin

species in each subbasin or ESU, e.g., green (increasing), red (decreasing), etc. as discussed above. Such a map might focus on Chinook and/or steelhead populations since these species are the most widely distributed throughout the Basin. Some data for this effort could be obtained from the NMFS webpage (www.webapps.nwfsc.noaa.gov/apex/f?p=238:home:0), which provides some adult population data in select tributaries of select ESUs (e.g., spawner counts, sometimes fraction of spawners that are wild, sometimes productivity). ESUs that are protected by the Endangered Species Act should be indicated. However, it would take some effort to filter through this web page and develop trend indices. Alternatively, the *2008-2017 U.S. v. Oregon Management Agreement* (Pp. 28-29) identified indicator stocks that might be used to show stock-specific population trends. A relatively productive and abundant stock of fall Chinook salmon is the Hanford Reach population. Spawner estimates including hatchery strays are available for 1979-2001 for Hanford (www.critfc.org/tech/02-3report.pdf); updates should be obtainable. Ideally, these trends would focus on natural origin salmonids because natural origin salmonids are more dependent on habitat than hatchery salmonids. However, the ISAB cautions that a problem with using a small subset of stocks is that they may not be representative of the all stocks.

If this approach is not feasible, another approach to add a diversity component to the abundance graphs might be to use numbers and coded arrows by direction to show how many stocks or DPSs or ESUs are increasing, decreasing, or stable. For example, in the wild fish abundance graph, one could use something like 22 ↑ 15 ↓ 25→ to indicate that 22 stocks are increasing, 15 are decreasing and 25 stocks are stable. The values and arrows should be color coded as suggested above.

Columbia River Basin Subbasins

1 Asotin	32 Lake Chelan
2 Big White Salmon	33 Lewis
3 Bitterroot	34 Little White Salmon
4 Blackfoot	35 Malheur
5 Boise	36 Methow
6 Bruneau	37 Okanogan
7 Burnt	38 Owyhee
8 Clark Fork	39 Palouse
9 Clearwater	40 Payette
10 Coeur D'Alene	41 Pend Oreille
11 Columbia Estuary	42 Powder
12 Columbia Gorge	43 Salmon
13 Columbia Lower	44 Sandy
14 Columbia Lower Mid	45 Sanpoil
15 Columbia Upper	46 Snake Headwaters
16 Columbia Upper Mid	47 Snake Hells Canyon
17 Cowlitz	48 Snake Lower
18 Crab	49 Snake Lower Middle
19 Deschutes	50 Snake Upper
20 Elochoman	51 Snake Upper Closed
21 Entiat	52 Snake Upper Middle
22 Fifteenmile	53 Spokane
23 Flathead	54 Tucannon
24 Grande Ronde	55 Umatilla
25 Grays	56 Walla Walla
26 Hood	57 Washougal
27 Imnaha	58 Weiser
28 John Day	59 Wenatchee
29 Kalama	60 Willamette
30 Klickitat	61 Wind
31 Kootenai	62 Yakima

Fig. 1.   As recommended by ISRP/ISAB (2009-2), a subbasin map such as this could be color-coded to indicated status trends of key species in each subbasin, e.g., green (increasing), red (decreasing), yellow (stable), white (unknown), or black (not present). The map might focus on Chinook and steelhead since these species are the most widely distributed, but the online version of the pamphlet might consider a map for each species. A map-based approach might be used to convey simple trends in other metrics, such as habitat restoration and protection. The time period covered by the trend should be noted. The influence of freshwater versus marine factors should be noted to the extent possible. See Fig. 2 also.

Productivity of salmonids also could be indicated with time series of smolt to adult survival (SARs), smolts per spawner, or adult returns per spawner. SAR data are available from Comparative Survival Study (CSS) documents. If data were available for all three metrics, then productivity in the ocean versus freshwater habitats could be identified.

Lamprey figure – The ISAB is concerned about the quality of the indices of lamprey abundance, but index counts such as these have been used and described in the status review by Close et al. (1995); they represent the best information currently available to describe lamprey status. It

may be important to point out that limitations and utility of the indices are not yet fully understood. In order to show the recent status of lamprey, which have reportedly declined over time, it would be useful to show data from earlier years, or to at least indicate the historical long-term mean index count. For example, Close et al. (1995) reported up to ~350,000 lamprey at Bonneville Dam and at the Dalles Dam in the 1960s. Missing values need to be identified on the chart.

White sturgeon figure – The chart mixes incomplete data for four different mainstem reaches, and therefore provides an inaccurate and confusing view of sturgeon abundance. If the abundance dataset for large sturgeon is used, it may be best to only use the most complete time series, i.e., abundance below Bonneville. Missing values must be indicated on the chart, otherwise viewers will misinterpret the chart. A much longer time series might be shown if harvest is used as a proxy for relative abundance, but nuances such as changing size limits must be considered. If the goal is to present information on the status of sturgeon throughout the entire Basin, then a color-coded map might be generated to highlight location-specific population trends (see comment above). Details about the trends used in this map should be described or referenced in the online version of the pamphlet.

Overall comment related to question 1

It could also be argued that because management of salmonids at this time is stock specific compared to the sturgeon, lamprey, and all other species, it may not be a good use of space to have one entire graph for sturgeon and a separate one for lamprey. Sturgeon, lamprey and *perhaps other fish and wildlife species* could be combined into one figure. For example, one could show a column of species on the left and status indicators on the right, color coded as increasing (green), decreasing (blue) or stable (yellow.). This approach (combining and perhaps expanding non-salmonids species) might allow more space for developing a map-based figure to address salmon diversity and spatial structure.

There are many species protected by the Endangered Species Act that inhabit the Columbia River Basin. The ISAB suggests a graph could show the number of ESA listed fish and wildlife species in the Basin versus the number of species that have been delisted. Colors could be used to identify species groups such as fishes, birds, mammals, amphibians, etc. This graph might also include the number of non-native invasive species that have colonized the Basin (color coded by type). The number of ESA species as well as invasive species (see ISAB 2008-4) in the Basin is quite high and this is an important message that should be delivered.

Habitat is a key component of the Fish and Wildlife Program, yet the three Council questions do not directly address habitat. Nevertheless, as noted by ISRP/ISAB (2009), the status of natural origin salmonids and wildlife is a key approach for evaluating cumulative effects of habitat quality on species of interest. It may be worthwhile to associate habitat quality to the status of species either through a statement or modification of the first question. For example, the diversity, productivity, and spatial distribution of non-hatchery salmonid populations will reflect the condition, diversity, and spatial representation of critical habitats and food webs associated

with them. If this approach is taken, then it is important to emphasize the status of natural origin salmonids rather than total salmonids, which include many hatchery fish. Natural origin salmonids depend on habitat more than hatchery salmonids. Trends in the population characteristics identified in this question could be used as a general indicator of habitat condition. However, the viewer of the pamphlet should be reminded that that these population characteristics reflect habitat condition along with year to year fluctuations in the environment and harvests.

HLI Report Question 2: Are mainstem hydropower dam operations meeting the Fish and Wildlife Program's survival and passage objectives?

Question 2 is more straightforward, but the Council's survival and passage objectives need to be shown with the data so that the reader has a reference with which to compare the data. Is survival meeting the survival objectives? Historic context could be added by showing survival rates in earlier years (for spring Chinook and steelhead survival estimates in 1966-80 and 1993-99 see Williams et al. 2001 in North American Journal of Fisheries Management 21:310-317). The ISAB recommends that the graphs provide estimates of variability or confidence in the survival estimates, if possible and further notes that adult survival rates exceeding 100% will confuse readers.

The purpose of the chart showing juvenile and adult counts at each dam in 2008 is not clear. Does the Council have objectives associated with these counts, as implied by the overall question? What message is being delivered by this chart that policy makers and others will find highly informative? The juvenile count data seem to be inaccurate because they decline from 237 million fish at Lower Monumental Dam to only 7 million at McNary Dam, which includes fish from the upper Columbia.

The hydro operations are not explicitly addressed in the graphics. A more detailed analysis is needed to identify which operations produce the best results and why. Further, how have modifications to the operations impacted survival and passage? What is working well and what is not?

HLI Report Question 3: Are Council Program actions coordinated within the Program and with other programs?

Question 3 is important in that the actions of the Council's Program should be coordinated both within the Program and with other programs. However, the HLI graphics did not specifically address the question of coordinated actions – and for policy makers it will be important to do so. Instead, habitat graphics were used to address Question 3. Habitat protection and restoration is an important feature of the Fish and Wildlife Program, so charts related to habitat are important. If habitat is the focus here, then the question should be changed. Please see

ISRP/ISAB (2009-2) about caveats associated with implementation actions, such as habitat restoration, with respect to recovery of fish and wildlife species.

The graphics do not address the question about coordinated activities. However, the Fish and Wildlife staff offered the following question as an alternative: "What is the progress of implementing the Council's Fish and Wildlife Program?" This question is much more relevant to the habitat graphics that are presented. Alternatively, this question could also be used as the overall question that is being addressed by the HLI pamphlet since trends in stock status are also a key approach for describing progress of the Program (see ISRP/ISAB 2009-2). This question could be answered by 1) fish population data (existing Question 1 or something similar), 2) survival through the dams (Question 2), and 3) actions to protect and restore habitat (existing charts). For example the question might be, how much habitat has been protected and restored through implementation of the Fish and Wildlife Program? Nevertheless, if the question is altered to focus on changes in habitat conditions rather than project coordination, then the ISAB believes that it would still be worthwhile to include a graph that quantifies coordination activities over time because coordination is very important to a successful program and it implies leadership.

Context, goals, or other reference points are needed in the first two habitat graphics. For example, how much habitat has been gained relative to what is currently available? How many miles of stream have been opened up in relation to what is isolated or what is currently available? Acres of habitat purchased for fish does not seem to provide useful information by itself. Presumably these purchases secure or allow unrestricted restoration of some habitats. Stating the amount of habitat in length or area of stream and the species that will benefit from the actions might be more useful. The graphics do not make it clear if the habitat purchased information is linked to or confounded with the graphic on stream miles that are "protected." Are the data of barriers removed shown in the second graphic linked to the graphic of stream miles made accessible? To convey the spatial aspect of the habitat actions, it would be worthwhile to show the habitat values by large region in the Basin (Fig. 2).
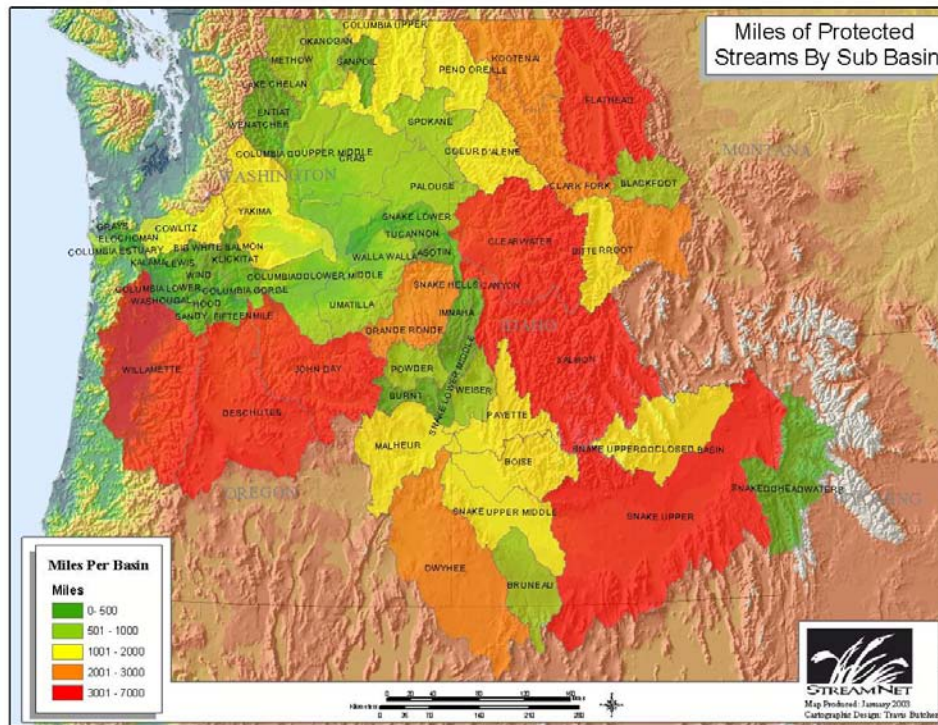
Fig. 2. Miles of streams protected from further hydro development in each subbasin. This map is an example of a figure type that might be used in the pamphlet to show progress with respect to habitat (although we would suggest a different color scheme, with red representing less protected habitats). The next step in this evaluation might be to calculate the percentage of "protected" stream miles in each subbasin. Map source: www.nwcouncil.org/fw/protectedareas/Default.htm

The last graphic showing wildlife habitat mitigation is much more useful than the first two graphics because the wildlife graphic provides context, i.e., wildlife habitat units lost versus the amount mitigated, and the goal for mitigation. However, most people will not be familiar with the location names shown here. A presentation of these data for several large areas of the Basin would be more informative. A graphic such as this for salmon would be useful.

C. Are the graphics easy to comprehend for non-scientists

Several comments in the section above "Overall comments relevant to all figures" directly address comprehension. Some questions may need to be modified in order to match the desired message and the data and graphics being shown. In general, the graphics in the pamphlet, as presented, would not be easy to understand by non-scientists. Fig. 3. shows a graphic that is considered to be one of the best statistical graphics of all time because it captures many quantitative values in a single, easy to interpret graphic.

D. Do the HLIs convey the Council's message that habitat is the base of the Program?

The graphs and limited amount of text do not convey the message that habitat is the base of the Fish and Wildlife Program. ISRP/ISAB (2009-2) noted that population trends (abundance, productivity, diversity, spatial distribution) of *natural origin salmonids* (and wildlife) may be used as a metric to evaluate overall habitat availability and condition (for salmonids), but this message needs to be developed in the pamphlet before the general public will make this connection.

The habitat figures attempt to address this question, but proper context is needed for the two fish habitat graphics (see comments above). If habitat is the base of the Program, it is discouraging to see that only 20 fish passage barriers were removed in 2008, as shown in the graphic, given that there are many culverts that block fish passage in the Columbia Basin.

E. Input on potential titles or a catchy header for the report

One composite title might be:
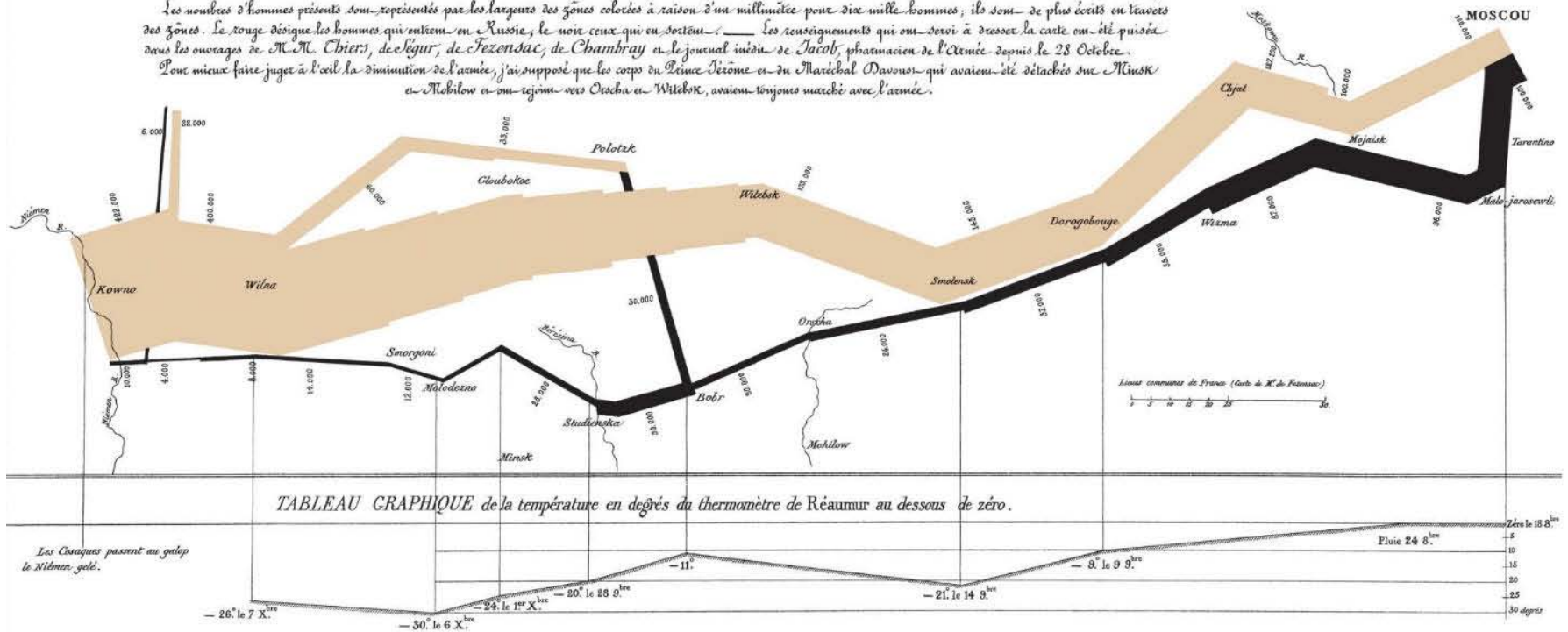
"Pathway to recovery and sustainability"

Fig. 3. This graphic is considered by E. Tufte, a expert on visual display of quantitative information, to be one of the best statistical graphics ever drawn. The graphic shows the fate of Napolean's army as it approached (beige band) and retreated (black band) from Moscow during 1812-1813. The graphic shows six variables, including army size across time and space, direction of army movement, and air temperature.

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