TECHNICAL SUPPLEMENT TO THE NPLCC STRATEGY FOR SCIENCE AND TRADITIONAL ECOLOGICAL KNOWLEDGE, 2013—2016

Document prepared by: Karen Jenni[1], Frank Shipley[2], and Mary Mahaffy[3]

([1]Insight Decisions, LLC, [2]U.S. Geological Survey, [3]North Pacific Landscape Conservation Cooperative)

November 2012

Table of Contents

Tables and Figures

The North Pacific Landscape Conservation Cooperative (NPLCC) seeks to *maximize the ability of partners to make informed decisions with respect to conservation and sustainable resource management of priority natural and cultural resources subject to climate change and related large-scale stressors in the NPLCC region.* A significant action undertaken by the NPLCC to meet this goal was development of a planning document, the *NPLCC Strategy for Science and Traditional Ecological Knowledge, 2013-2016* (S-TEK Strategy) *(*http://www.fws.gov/pacific/Climatechange/nplcc/*).*

The NPLCC Science and Traditional Ecological Knowledge Subcommittee (Subcommittee) developed the S-TEK Strategy over about a six-month period, meeting two times in person and nine times by phone and through web-based meetings. This Technical Supplement provides additional details on each of the steps in the S-TEK Strategy development process. It is intended to be read as an accompaniment to the S-TEK Strategy*,* adding detail to that document but not reproducing what is summarized therein.

Section 1 lists the Subcommittee members and summarizes the timeline of activities they undertook to develop the S-TEK Strategy. Sections 2 through 5 describe the main technical steps in strategy development corresponding to three of the steps shown in Figure 2 of the S-TEK Strategy:

- Identify potential information and support needs (Section2)
- Evaluate and rank those needs (Sections 3 and 4)
- Develop the S-TEK portfolio (Section 5)

Section 6 compares the portfolio of actions developed under the S-TEK Strategy to potential focus areas identified by the National Wildlife Federation (NWF) through their focus group process (described in Section III of the S-TEK Strategy). Section 7, the final section, explores the implications of the detailed evaluations of potential topics for annual implementation planning.

1. Subcommittee Members, Meetings and Activities

The Subcommittee included 33 members, representing seven US Federal Agencies, three of the four US States within the NPLCC, five conservation-oriented non-governmental organizations, two Tribes, the Northwest Climate Science Center, the NOAA Regional Integrated Science Assessment, and University of Oregon's Tribal Climate Change Project. Some of the Subcommittee members were nominated by the Steering Committee and others were selected to provide geographical balance and representation of different entities. Subcommittee members were asked to consider needs across the NPLCC as a whole, rather than those that might be specific to their own entities' needs. The Subcommittee recognized that its composition would have been stronger if there were additional Tribal/First Nations participants and representatives from both British Columbia and Oregon. Table 1 lists the Subcommittee members, and Table 2 shows a timeline of the main activities of the Subcommittee.

Table 1. Subcommittee members and meeting participants

Name	Entity
Andrea Woodward	US Geological Survey
Bill Hanson	US Fish and Wildlife Service
Bruce Duncan	US Environmental Protection Agency
Charles Chamberlain	US Fish and Wildlife Service
Chris Lauver	National Park Service
Dan Siemann	National Wildlife Federation
Dominick DellaSala	GEOS Institute
Frank Lake	US Forest Service
Frank Shipley (Chair)	US Geological Survey
Jennie Hoffman	EcoAdapt
John Laurence	US Forest Service
John Alexander	Klamath Bird Observatory
Judy Gordon	US Fish and Wildlife Service
Judith Ramos	Central Council Tlingit and Haida Indian Tribes of Alaska
Karyn Gear	CA Coastal Conservancy
Kathleen Sloan	Yurok Tribe
Kathie Dello	Oregon State University
Kathy Lynn	University of Oregon
Kathryn Boyer	Natural Resources Conservation Service
Keith Hatch	Bureau Indian Affairs
Kelly Nesvacil	Alaska Dept. of Fish and Game
Lyman Thorsteinson	US Geological Survey
Mark Kramer	US Forest Service
Marcus Miller	Natural Resources Conservation Service
Mark Petrie	Ducks Unlimited
Mike Goldstein	US Forest Service
Peter Kiffney	National Ocean Atmospheric Administration
Phil van Mantgem	US Geological Survey
Raymond Paddock	Central Council Tlingit and Haida Indian Tribes of Alaska
Steve Morey	US Fish and Wildlife Service
Sue Rodman	Alaska Dept. of Fish and Game
Timothy Quinn	Washington Dept. of Fish and Wildlife
Whitney Albright	California Dept. of Fish and Game
Participants not formally part of the Subcommittee	
John Mankowski	NPLCC Coordinator
Karen Jenni	Insight Decisions, LLC
Mary Mahaffy	NPLCC Science Coordinator

Table 2. Subcommittee meetings and key activities

Subcommittee Meeting	S-TEK Strategy Development Activity
Feb 29 (in person meeting)	Roles and responsibilities Overview NPLCC mission and goals Reviewed NPLCC Conceptual Models created by USGS Reviewed results NWF efforts to date
April 5 (call / web)	• Reviewed and discussed prior Steering Committee work that gave the Subcommittee a starting point: ➢ Decisions the NPLCC support ➢ Outcomes of interest to those decision-makers • Developed draft objectives for the *NPLCC Strategy for Science and Traditional Ecological Knowledge* (hereafter, "S-TEK Strategy") • Discussed the process to be used to develop the S-TEK Strategy
May 8 (call / web)	• Agreed on overall process to be used • Focused discussion on identification of potential science and information needs: ➢ Potential needs identified already ➢ Established a set of three conference calls for Subcommittee members to further identify potential needs
May 10 – June 10 (three ecosystem work group calls)	• Work group calls • Identified (additional) information and support needs: ➢ Building from and adding to ongoing work
June 13-14 (in person)	• Finalized objectives of the S-TEK Strategy • Discussed results NWF efforts to date • Developed criteria to evaluate the relative importance of different topic / focus area • Identified several challenges for developing a useful strategy • Discussed work-to-date on identifying potential information needs • Agreed to use an "impact matrix" approach as a first pass at narrowing the list of potential topics ➢ ~20 primary and secondary climate-relate drivers of change ➢ ~20 categories of natural and cultural resources of interest • Subcommittee to consider the impact of the drivers on the resources & identify those most important for the NPLCC
Between meetings 20 Subcommittee members provided input on which resource-driver pairs represent more important topics for the NPLCC to consider	
July 10 (call / web)	• Reviewed results of "impact matrix" scoring • Initial discussions of how to separate and highlight "Priority Principles" from the potential topics areas • Selected a "short list" of potential topics to be evaluated in more detail ➢ Agreed on criteria and priority scoring process

Subcommittee Meeting	S-TEK Strategy Development Activity
Between meetings 23 Subcommittee members completed the detailed scoring of a subset of the "high priority" topics	
Aug 10 (call / web)	• Reviewed results of priority scoring • Reviewed draft NWF synthesis report on focus group results • Developed initial drafts of ➢ Priority Topics ➢ Priority Principles
Aug 28	Presented preliminary results to NPLCC Steering Committee for review and comment
Sept 26 (call / web)	Review draft of S-TEK Strategy document

2. Identification of Potential Information and Support needs

The S-TEK Strategy development process started with the identification of potential information and support needs. Figure 3 in the S-TEK Strategy displays the different sources of information used to develop the "long list" of potential needs. The long list was envisioned as a starting point, an organization of all the possible decision-relevant topics the NPLCC could address.

The approaches initially used by the Steering Committee and Subcommittee started with identifying end-user decisions and then identified science and information needed to support those decisions. The NWF work started with stakeholder identified climate-related "challenges and opportunities," and then identified potential information and support needs related to those challenges and opportunities. Subcommittee members also felt it was important to look at this question from an ecosystem and ecological modeling perspective. To accomplish this, the Subcommittee used the NWF syntheses and focus group results as they became available, and worked through the following steps:

1) Identified "resources of management concern" for each of the various NPLCC partner agencies. These resources included individual species (e.g., for U.S. Fish and Wildlife Service; state resource agencies), rare habitats (e.g., for the National Park Service (NPS)), specific historical or culturally-important locations and structures (e.g., for Tribes; NPS), specific forest areas (e.g., for the U.S. Forest Service), etc. This focus on specific resources added detail to several of the categories of decisions important to the NPLCC, and facilitated the identification of management-relevant information needs.

2) Identified the processes and drivers by which climate change and related stressors may affect those resources, and how impacts on the resources of management interest may affect the outcomes of interest defined for the NPLCC. The Subcommittee discussed the direction, size, and uncertainty in those effects.

3) Identified types of possible management actions that could prevent, mitigate, or offset any predicted adverse effects or increase any beneficial effects identified in Step 2. The focus was not on defining specific management actions, but rather on identifying whether potential response actions exist for the anticipated climate change and related effects.

4) Considered what additional knowledge and information about climate change and its direct and indirect impacts would help any of the NPLCC partners make a choice among alternative ways of managing the resource(s) for which they have responsibility.

Subcommittee members also discussed the importance of identifying information and support gaps being addressed by various organizations, and which gaps remained that the NPLCC should fill. They recognized that identifying relevant existing and ongoing work, and highlighting gaps within a topic will require significant effort. Subcommittee members identified that these steps should be part of the annual planning process.

3. Organizing and Screening Potential Topics

A challenge for the Subcommittee was how to organize and structure the lists of potential climate-related information and support needs in way that they could be evaluated, compared, and ranked. The numerous potential needs that emerged from that work were a mix of types of support (e.g., decision-support tools), topics (e.g., effects of storms on coasts), needs related to impacts (e.g., vulnerability assessments), information on the effectiveness of adaptation and mitigation actions, ecosystem-scale needs with broad uncertainties (e.g., cumulative impacts of climate change on habitats), and very specific activities (e.g., long-term large mammal monitoring). There was no obvious framework around which potential information and support needs could be organized at an appropriate level of aggregation for the S-TEK Strategy. The diversity of the identified needs led to a decision to separate consideration of specific topical issues from discussion of principles and common approaches or concepts that apply across topics. As a result, *Priority Topics* and *Guiding Principles* became the cornerstones of the S-TEK Strategy.

The Subcommittee adapted an "impact matrix" approach to organize the topical information and support needs that were identified through the processes described above (NWF science synthesis reports and focus groups; three Subcommittee working groups corresponding to coastal/marine, freshwater/riparian, and terrestrial ecosystem types; and a two-day Subcommittee workshop). The impact matrix, similar to approaches used elsewhere,[1,2] was developed by separating climate-related

[1]National Research Council (1990). Managing troubled waters. The role of marine environmental monitoring. Nat. Acad. Press, Washington, D.C.

[2] Shipley, Frank (1991). "Characterizing Galveston Bay: Connecting Science and Management at the Ecosystem Level," in Proceedings: Galveston Bay Characterization Workshop, Webster, Texas. GDNEP-6. Available online at: http://gbic.tamug.edu/gbeppubs/6/gdnep6_03-11.pdf (accessed 9/20/2012)

drivers of change from the valued natural and cultural resources that could be affected by those changes.

Figure 1 shows the impact matrix template, and Section 3.1 provides the lists and definitions of climate change-related drivers and of valued natural and cultural resources listed in the matrix. Each cell represents the impact of a climate-related driver of change on a valued resource type (e.g., the first cell represents the impacts of changes in atmospheric composition on forest habitats), and thus each represents a potential topic where additional information or support could be useful. This structure was used to conduct an initial screening of potential topics, reducing hundreds of possible topics down to a shorter list. The purpose of this exercise was to screen out topics of less importance and identify topics that warranted more detailed evaluation and consideration before identifying Priority Topics for the S-TEK Strategy.

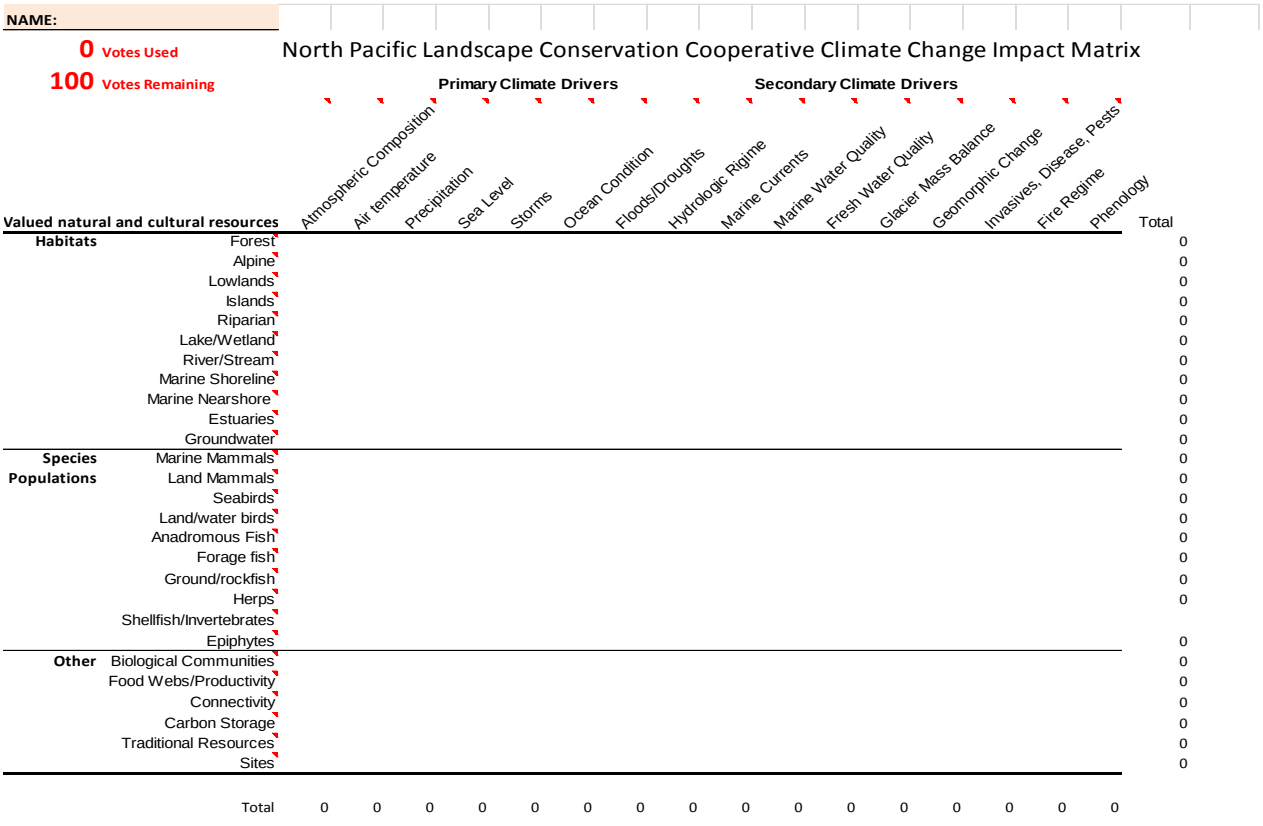

Figure 1. The Impact Matrix Template

3.1 Definitions of NPLCC Climate Change Drivers and Valued Resources

Tables 3 and 4 provide the definitions of the climate-related drivers and of the valued natural and cultural resource elements in the impact matrix. These definitions were provided to the Subcommittee as part of the package of instructions for how to use the matrix to score driver/resource pairs.

Table 3. Definitions of NPLCC primary and secondary climate-related drivers of change

Primary	
Atmospheric Composition	Relative gas concentrations, change rate and direction
Air temperature	Mean and seasonal atmospheric temperature, trends, geographic variability
Precipitation	Timing and amount of rain, snow, fog, snowpack
Sea Level	Increases, decreases, rates, geographic variability
Storms	Coastal storm dynamics--frequency, intensity, duration, wave height, wind speed, seasonal timing, tidal interactions, extreme events
Ocean Condition	Relative gas concentrations, change rate and direction
Secondary	
Floods/Droughts	Frequency, severity, geographic variation, trends
Hydrologic Regime	Instream river and stream flow changes, seasonality, rain vs snow effects
Marine Currents	Temperature, wind, and density driven current changes, upwellings, gyres, geographic variations and trends
Marine Water Quality	Temperature, runoff pollutant concentrations, turbidity, hypoxia, bloom-driven changes
Fresh Water Quality	Temperature, seasonal and geographic variation, glacial and runoff-driven turbidity, changing constituent concentrations
Glacier Mass Balance	Declines/advances, newly exposed substrates
Geomorphic Change	Accretion and erosion of freshwater and marine substrates, particle size, seasonal change events
Invasives, Disease, Pests	Invasive species introductions and expansions, new pathogens and expansion of native pathogens and species
Fire Regime	Frequency, severity, geographic distribution of fires, occurrence of extreme events
Phenology	Plant, animal life cycle event timing, changes from climate, disconnection of related species and events, timing driven new ecological relationships

Table 4. Definitions of NPLCC valued natural and cultural resources and attributes

Habitats	
Forest	Coastal, inland, montane, health, productivity, age structure, composition, distribution, fuels
Alpine	Tundra, glaciers, snowpack, trends and changes
Lowlands	Prairie/oak woodlands, agricultural lands
Islands	Insularity, endemism, susceptibility to threats
Riparian	River, stream corridors, floodplains
Lake/Wetland	Water constituent concentrations, temperature, stratification, nutrient cycling, water levels, seasonal patterns
River/Stream	Ecological flow, temperature regime, constituent concentrations, runoff driven changes, groundwater driven changes
Marine Shoreline	Shoreline above mean high tide: beach, coastal marsh/wetlands, terrestrial near-

	shore
Marine Nearshore	Intertidal, kelp/seagrass habitats, benthic and pelagic habitats, all substrates
Estuaries	Bays and deltas with salinity gradients, benthic and pelagic habitats, temperature and geomorphic changes, salinity gradient changes
Groundwater	Aquifers, recharge rates and trends, salt water intrusion, surface water connectivity including seeps, springs, and stream/river base flow
Species Populations	
Marine Mammals	Reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Land Mammals	Reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Seabirds	Reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Land/water birds	Reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Anadromous Fish	Salmonids, lampreys: reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Forage fish	Marine/estuarine species: reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Ground/rockfish	Inshore (coastal shelf and nearshore): reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Herps	Amphibians, reptiles: reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Shellfish/Invertebrates	Nearshore marine/estuarine species: reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species
Epiphytes	Forest species algae/fungi/moss: reproduction, mortality, population size, genetic integrity, range/distribution
Emergent Attributes	
Biological Communities	Species composition and interactions: degree of co-evolution, predation, competition, biodiversity, mutualism, veg cover alterations
Food Webs/Productivity	Terrestrial, aquatic, marine, soil productivity, keystone species, primary productivity, secondary productivity, energy flow
Connectivity	Degree of integration, fragmentation, disruption, effects on movements and migrations, geographic change, all habitats
Carbon Storage	Carbon storage capability, trends
Other	
Traditional Resources	First foods, materials, medicines, ceremonial
Sites	Archeological, cultural and historically significant sites

3.2 Impact Matrix Scoring Instructions

To begin the identification of Priority Topics, Subcommittee members were given instructions for matrix scoring to narrow the potential areas of focus. The shorter list that emerged from this initial narrowing was then further evaluated and ranked (see Section 4).

In the scoring instructions, Subcommittee members were asked to consider several factors in estimating the "importance" (and hence their scoring) of any given driver-resource pair (topic). Most critical for the NPLCC was the degree to which information or support related to a topic is needed to support natural resource management decisions within the NPLCC. Factors affecting that criticality included (1) the

magnitude or importance of the effect of the driver on the resource, (2) the level of uncertainty about those impacts, and (3) the necessity and ability of resource management agencies to mitigate, adapt, or respond to the anticipated changes. It was noted in the instructions that a significant management-relevant impact across a large portion of the ecoregion should be ranked higher than a geographically or topically narrow issue. Subcommittee members were asked to avoid scoring the topics based on their personal interest and instead to use their knowledge and expertise to identifying the issues that are broadly mission-critical.

Additional instructions were as follows:

- To think of this exercise as similar to the "dot voting" often used in groups to select a small number of topics to be explored in depth from a longer list developed through brainstorming or similar processes.
- To allocate up to 100 total points to score the matrix, entering from 0 to 5 points in any given cell such that a higher score denotes higher priority for that topic.
- To consider high priority (high score) to mean those topics that the NPLCC should address in the next 4 years.
- To try to give positive scores to a minimum of 10 topics (although it was anticipated that Subcommittee members would identify more than this).

Evaluators were told that analyses would be summarized in a variety of ways, including both counts of number of individuals entering a positive score for each cell (unweighted cell importance) and the total point score of each cell (weighted cell importance)Subcommittee members were reminded that very little in ecology can be represented in two dimensions. Elements can be both causes and effects in complex ways, and the matrix is merely an approximation and a tool.

Evaluators were told to consider that some of the primary drivers may tie more directly to research questions than to resource management decisions, while some secondary drivers are critically important to climate change response. Additionally, evaluators were told that matrix scoring results are not intended to tie one-to-one with future NPLCC projects. Development of projects will be deliberative in light of the scoring exercise. Finally, although the matrix includes the potential for any climate driver to affect any resource, the Subcommittee recognized that some of the relationships did not make sense (e.g. sea level and epiphytes), and evaluators were told to not score those cells.

3.3 Impact Matrix Results

More than half of the Subcommittee members completed the exercise (n=20, 100 points per individual). Figure 2 shows the weighted score totals, color coded so that those receiving the highest number of points are in green, and those receiving zero points are in red. A total of 242 driver/resource pairs received at least one point. Of those receiving points, there were 47 that received a total of only 1 or 2 points, and 145 that were assigned points by only 1 or 2 participants, indicating that these driver/resource pairs were not widely considered important. On the high end of scores, 38 pairs received at least one point from 5 or more of the participants and 10 pairs received at least one point from 10 or more participants. Sensitivity analysis revealed good agreement between unweighted scores (each cell with non-zero points counted as one), and the weighted scores (the sum of all the points assigned by members to each cell). Figure 3 shows similar curve shapes comparing weighted and unweighted totals for the 96 highest-scoring pairs.

Valued natural and cultural resources		Atmospheric Composition	Air temperature	Precipitation	Sea Level	Storms	Ocean Condition	Floods/Droughts	Hydrologic Regime	Marine Currents	Marine Water Quality	Fresh Water Quality	Glacier Mass Balance	Geomorphic Change	Invasives, Disease, Pests	Fire Regime	Phenolo
Habitats	Forest	4	30	31	0	6	0	13	7	0	0	0	0	0	32	0	10
	Alpine	1	18	7	0	0	0	5	2	0	0	0	11	0	0	0	4
	Lowlands	0	7	9	1	1	1	13	1	1	0	0	0	0	4	11	0
	Islands	0	5	5	12	5	0	0	0	0	0	0	0	0	3	0	1
	Riparian	3	9	14	3	0	0	26	24	0	0	3	0	0	2	5	1
	Lake/Wetland	3	17	19	0	0	0	5	14	0	0	14	0	0	0	0	5
	River/Stream	3	22	26	0	5	0	26	51	0	0	27	4	15	1	9	5
	Marine Shoreline	0	5	0	43	20	5	0	0	3	2	0	0	4	0	0	0
	Marine Nearshore	0	5	5	25	12	11	0	0	7	6	1	0	0	1	0	0
	Estuaries	2	0	10	43	13	11	5	15	6	4	6	4	11	0	0	0
	Groundwater	0	5	11	2	0	0	12	23	0	5	10	0	5	0	5	5
Species	Mammals	0	4	0	3	0	10	0	0	2	5	0	0	0	0	0	1
Populations	Mammals	0	18	9	0	0	0	4	3	0	0	0	0	0	3	5	4
	Seabirds	0	0	0	7	4	8	0	0	5	1	0	0	0	0	0	0
	Land/water birds	0	8	8	0	0	0	5	3	0	0	0	0	0	1	1	1
	Anadromous Fish	5	9	8	3	1	10	11	36	9	14	27	0	2	1	5	0
	Forage fish	0	0	0	10	4	11	0	3	5	7	0	0	2	1	0	0
	Ground/rockfish	0	0	0	0	0	8	0	3	2	4	0	0	0	0	0	0
	Herps	0	5	5	2	0	5	7	2	0	0	3	0	0	3	0	3
	Shellfish/Invertebrates	0	2	2	5	2	24	0	1	1	12	2	0	0	0	0	1
	Epiphytes	1	7	7	0	0	0	1	0	0	0	0	0	0	0	2	0
Other	mmunities	5	20	14	7	3	8	6	3	3	0	0	0	0	25	7	19
Food Webs/Productivity		6	11	11	5	7	15	6	1	2	7	3	0	0	15	3	15
Connectivity		4	13	12	5	6	1	8	3	0	0	0	1	1	0	11	0
Carbon Storage		7	10	10	3	3	8	9	0	0	5	0	0	0	4	17	0
Traditional Resources		6	11	16	16	3	8	6	10	0	5	10	2	0	4	14	9
	Sites	3	5	5	21	10	0	0	0	0	0	0	0	7	0	1	0

Figure 2. Impact Matrix Scoring

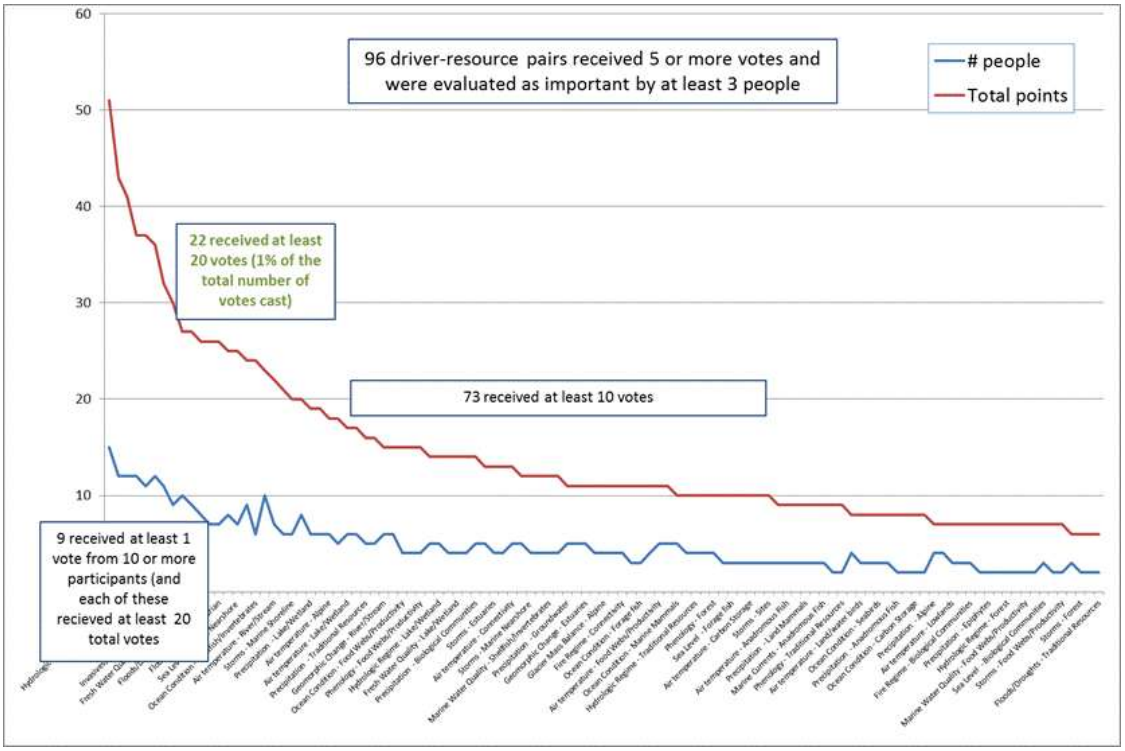

Figure 3. Weighted and Unweighted Scores for Higher-scoring Topics

3.4 Final Short List of Topics

The Subcommittee reviewed and discussed the results presented above, and identified strengths and weaknesses of the impact matrix approach for screening topics. As noted in Shipley (footnote 2), and in the instructions provided to the evaluators, the matrix approach does not allow representation of *all* relevant relationships, and in particular the effects of primary drivers on secondary drivers cannot be captured directly. Subcommittee participants noted that the process required them to combine a large number of factors simultaneously and informally, and suggested that results may have been different for a different set of evaluators, or for slightly different definitions of the drivers and resources. However, they also noted that their individual evaluations had many similarities, and felt that the process was a useful and efficient way to narrow the list of topics further to create a short list that would be evaluated and considered in more depth.

Based on the results of the impact matrix and subsequent discussion, the Subcommittee chose to focus on a short list of 22 driver-resource pairs that received at least 20 points (Figure 4). As described in the S-TEK Strategy, those 22 topics combined received more than 30% of the total number of points allocated, and each individually received at least 1% of the total number of points allocated.

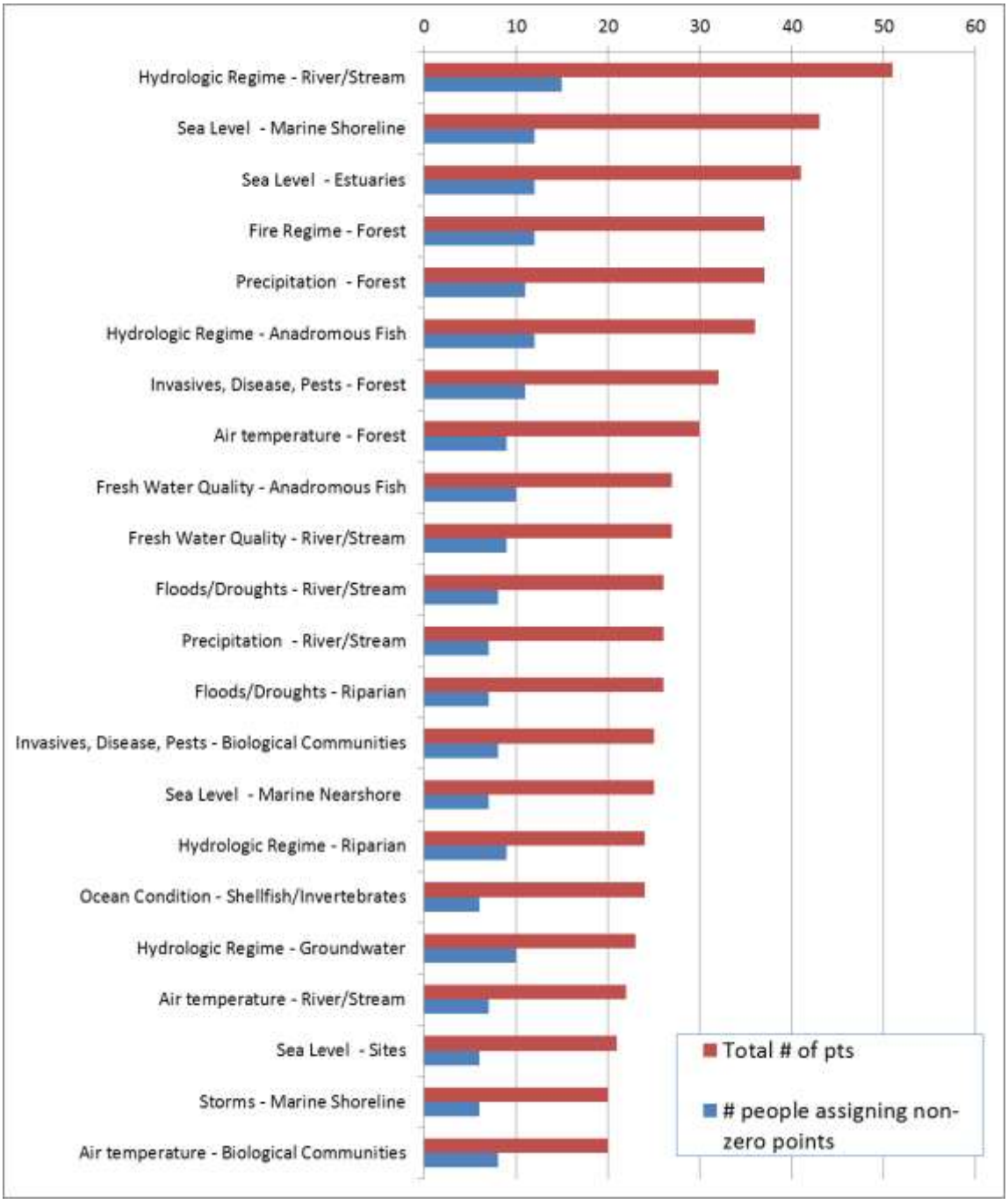

Figure 4. Weighted and Unweighted Results of the Screening-level Evaluation: Scores for the 22 Highest-scoring Topics

4. Evaluating and Ranking Topics

The Subcommittee recognized the need to further evaluate and rank the short list of topics to identify the highest priority topics to include in the S-TEK Strategy. Additional evaluation criteria and portfolio balancing factors were established and used to evaluate each of the topics identified above. To facilitate evaluation, the 22 topics (driver/resource pairs) on the short list were divided into six categories.

4.1. Priority Topic Categories

Dividing the 22 topics into six categories allowed Subcommittee members to evaluate a subset of the topics where their subject matter expertise could best be applied. The six categories included one with marine ecosystem topics, one with forest topics, three with freshwater associated topics, and one with cross-ecosystem topics (Table 5). Subcommittee members were invited to score as many of the categories as they felt they had the expertise and time for. They were instructed to evaluate all the topics within each category they were evaluating for consistency. An attempt was made to have an equal number of evaluators for each group.

Table 5. Categories of topics identified as potential priorities for the S-TEK Strategy

<table>
<tr><th>Driver-resource pair(s)</th><th>Definitions</th></tr>
<tr><td>Category 1 (Marine)
Sea Level - Marine Shoreline
Storms - Marine Shoreline
Sea Level - Estuaries
Sea Level - Marine Nearshore
Ocean Condition - Shellfish/Invertebrates
Sea Level - Sites</td><td>
<table>
<tr><td>Sea Level</td><td>Increases, decreases, rates, geographic variability</td></tr>
<tr><td>Storms</td><td>Coastal storm dynamics--frequency, intensity, duration, wave height, wind speed, seasonal timing, tidal interactions, extreme events</td></tr>
<tr><td>Ocean Condition</td><td>Relative gas concentrations, change rate and direction</td></tr>
</table>
<table>
<tr><td>Marine Shoreline</td><td>Shoreline above mean high tide: beach, coastal marsh/wetlands, terrestrial near-shore</td></tr>
<tr><td>Marine Nearshore</td><td>Intertidal, kelp/seagrass habitats, benthic and pelagic habitats, all substrates</td></tr>
<tr><td>Estuaries</td><td>Bays and deltas with salinity gradients, benthic and pelagic habitats, temperature and geomorphic changes, salinity gradient changes</td></tr>
<tr><td>Shellfish/ Invertebrates</td><td>Nearshore marine/estuarine species: reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species</td></tr>
<tr><td>Sites</td><td>Archeological, cultural and historically significant sites</td></tr>
</table>
</td></tr>
<tr><td>Category 2 (Forest)
Fire Regime - Forest
Precipitation - Forest
Invasives, Disease, Pests - Forest</td><td>
<table>
<tr><td>Air temperature</td><td>Mean and seasonal atmospheric temperature, trends, geographic variability</td></tr>
<tr><td>Precipitation</td><td>Timing and amount of rain, snow, fog, snowpack</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Driver-resource pair(s)</th><th>Definitions</th></tr>
<tr><td>Air temperature - Forest</td><td>
<table>
<tr><td>Invasives, Disease, Pests</td><td>Invasive species introductions and expansions, new pathogens and expansion of native pathogens and species</td></tr>
<tr><td>Fire Regime</td><td>Frequency, severity, geographic distribution of fires, occurrence of extreme events</td></tr>
</table>
<table>
<tr><td>Forest</td><td>Coastal, inland, montane, health, productivity, age structure, composition, distribution, fuels</td></tr>
</table>
</td></tr>
<tr><td>Category 3 (Freshwater)
Hydrologic Regime - Anadromous Fish
Fresh Water Quality - Anadromous Fish</td><td>
<table>
<tr><td>Hydrologic Regime</td><td>Instream river and stream flow changes, seasonality, rain vs snow effects</td></tr>
<tr><td>Fresh Water Quality</td><td>Temperature, seasonal and geographic variation, glacial and runoff-driven turbidity, changing constituent concentrations</td></tr>
</table>
<table>
<tr><td>Anadromous Fish</td><td>Salmonids, lampreys: reproduction, mortality, population size, genetic integrity, range/distribution, habitat use, trust species, listed species</td></tr>
</table>
</td></tr>
<tr><td>Category 4 (Freshwater)
Hydrologic Regime - Riparian
Floods/Droughts - Riparian
Floods/Droughts - River/Stream
Hydrologic Regime - Groundwater</td><td>
<table>
<tr><td>Hydrologic Regime</td><td>Instream river and stream flow changes, seasonality, rain vs snow effects</td></tr>
<tr><td>Floods/Droughts</td><td>Frequency, severity, geographic variation, trends</td></tr>
</table>
<table>
<tr><td>Riparian</td><td>River, stream corridors, floodplains</td></tr>
<tr><td>River/Stream</td><td>Ecological flow, temperature regime, constituent concentrations, runoff driven changes, groundwater driven changes</td></tr>
<tr><td>Groundwater</td><td>Aquifers, recharge rates and trends, salt water intrusion, surface water connectivity including seeps, springs, and stream/river base flow</td></tr>
</table>
</td></tr>
<tr><td>Category 5 (Freshwater)
Hydrologic Regime - River/Stream
Precipitation - River/Stream
Air temperature - River/Stream
Fresh Water Quality - River/Stream</td><td>
<table>
<tr><td>Hydrologic Regime</td><td>Instream river and stream flow changes, seasonality, rain vs snow effects</td></tr>
<tr><td>Air temperature</td><td>Mean and seasonal atmospheric temperature, trends, geographic variability</td></tr>
<tr><td>Precipitation</td><td>Timing and amount of rain, snow, fog, snowpack</td></tr>
<tr><td>Fresh Water Quality</td><td>Temperature, seasonal and geographic variation, glacial and runoff-driven turbidity, changing constituent concentrations</td></tr>
</table>
<table>
<tr><td>River/Stream</td><td>Ecological flow, temperature regime, constituent concentrations, runoff driven changes, groundwater driven changes</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Driver-resource pair(s)</th><th>Definitions</th></tr>
<tr><td>Category 6 (Cross-Ecosystems)
Invasives, Disease, Pests - Biological Communities
Air temperature - Biological Communities</td><td>
<table>
<tr><td>Invasives, Disease, Pests</td><td>Invasive species introductions and expansions, new pathogens and expansion of native pathogens and species</td></tr>
<tr><td>Air temperature</td><td>Mean and seasonal atmospheric temperature, trends, geographic variability</td></tr>
</table>
<table>
<tr><td>Biological Communities</td><td>Species composition and interactions: degree of co-evolution, predation, competition, biodiversity, mutualism, veg cover alterations</td></tr>
</table>
</td></tr>
</table>

4.2. Criteria and Balancing Factors

To develop the ranking tool for the screened topics, evaluation criteria and balancing factors were developed and agreed upon by the Subcommittee:

Evaluation criteria:

- Value of information for decision-making
- Breadth of need across NPLCC stakeholders
- Importance of LCC-level participation.
    - How large is the information or support gap?
    - How critical the LCC is to filling that gap?
- Timing of need

Portfolio balancing factors:

- Relevance to three ecosystems: Marine/coastal, freshwater, and terrestrial
- Relevance of the topic to the States, Province, Tribes/First Nations that are part of the NPLCC
- Relevance of the topic to outcomes of interest identified by the Steering Committee
- Geographic scale of the issue

4.3 Evaluation Criteria Metrics and Scales

Metrics and scoring scales for the evaluation criteria defined different levels of "performance" on each metric that the Subcommittee felt reflected meaningful differences in importance (Table 6).

In developing the metrics, several factors were considered**:**

- The NPLCC Steering Committee identified several types of decisions that the NPLCC aims to support. "Value of information for decisions" was evaluated for each of these six major categories of decisions (Table 6).

- Decision sensitivity was identified as a factor that might be important to consider in comparing the value of obtaining information on potential topics. Subcommittee members identified three types of sensitivity that would be of interest (Table 6), and each topic was evaluated for each of these types of sensitivity.
- To avoid possible duplication with other projects in the region, the Subcommittee decided to focus on issues for which the NPLCC can clearly add value for stakeholders. The Subcommittee identified several different types of information and support that might be necessary to support decisions (Table 6), and the importance and role of LCC support for each type of information was scored.
- Timing needs were recognized as useful information for implementation planning. Unique near-term opportunities corresponding to rare or significant natural events (e.g., a 100-year flood) or project leveraging with other projects in the region were seen as opportunities. Evaluators were asked to identify any such "opportunity drivers" for the timing of a project by indicating if there are any such opportunities in the next 2 years.

Table 6. Metrics and scoring scales for topic evaluation criteria

<table>
<tr><th>Evaluation Criteria</th><th>Scale(s)</th></tr>
<tr><td>Value of Information for decisions

Two metrics were used:
a) Value of information on the potential topic for each of six types of management decisions
• Protection, mitigation, and restoration of habitats
• Species management
• Land use and management
• Water use and management
• Protection of cultural and historic resources
• Management/ response to disturbances
b) Importance or sensitivity of the topic and decisions related to that topic 1) to biological or human impacts, 2) legally, or 3) politically</td><td>a) Value of information on the potential topic:
<table><tr><th>Score</th><th>Definition / Description</th></tr><tr><td>4</td><td>Critical</td></tr><tr><td>3</td><td>Useful</td></tr><tr><td>2</td><td>Limited use</td></tr><tr><td>1</td><td>Not applicable</td></tr></table>
b) Importance or sensitivity:
<table><tr><th>Score</th><th>Definition / Description</th></tr><tr><td>3</td><td>Highly sensitive</td></tr><tr><td>2</td><td>Somewhat sensitive</td></tr><tr><td>1</td><td>Not sensitive</td></tr></table></td></tr>
</table>

<table>
<tr><th>Evaluation Criteria</th><th>Scale(s)</th></tr>
<tr><td>Breadth of Partnership Need</td><td>
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>4</td><td>Information and support is relevant to the decisions of a large majority (almost all) NPLCC stakeholders</td></tr>
<tr><td>3</td><td>Information and support is relevant to the decisions of most NPLCC stakeholders</td></tr>
<tr><td>2</td><td>Information and support is relevant to the decisions of a limited number of NPLCC stakeholders</td></tr>
<tr><td>1</td><td>Information and support is not relevant to stakeholders decisions</td></tr>
</table>
</td></tr>
<tr><td>Importance and role for NPLCC support

Two metrics were used:
a) Are you aware of relevant work of this type that is already being done?
b) How important is it that the LCC support additional work of this type?

And scores were required for each of four different types of information and support:
• Basic, fundamental, or “new” science, TEK, information, data or modeling (expanding or refining what’s known about new or nascent areas of research; also information ‘nobody’ knows)
• Analyses, integration, and synthesis of existing data, datasets, models and information
• Coordination and sharing of related databases and data collection activities, research results, tools, and management lessons among partners, made accessible in a useful and useable format
• Understanding of and ability to use relevant information in decision-making (help in using information appropriately and effectively)</td><td>a) Aware of relevant work:
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>4</td><td>Not aware of activities of this type being conducted; anticipate significant additional would be necessary to fully address this topic</td></tr>
<tr><td>3</td><td>Some activities of this type are being conducted; there remain significant gaps where additional work would help to address the topic</td></tr>
<tr><td>2</td><td>Significant activity of this time is underway; some gaps remain where additional work could be helpful</td></tr>
<tr><td>1</td><td>Major (large and/or numerous) activities of this type are being conducted related to this topic; little to no additional work is necessary to fully address topic</td></tr>
</table>
b) Importance of support:
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>4</td><td>Clear gaps exist that require multi-entity and/or cross-boundary work; the LCC is uniquely suited to providing this type of information or support</td></tr>
<tr><td>3</td><td>Significant gaps are known or suspected to exist; it is unlikely that these gaps will be addressed without LCC support</td></tr>
<tr><td>2</td><td>Some gaps are known or suspected; those gaps could be addressed by existing entities</td></tr>
<tr><td>1</td><td>Few gaps exist and/or those that do are likely to be addressed by existing entities</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Evaluation Criteria</th><th>Scale(s)</th></tr>
<tr><td>Timing of need

When would the LCC need to initiate work on a topic to support critical decisions?</td><td>
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>3</td><td>Within 1-2 years</td></tr>
<tr><td>2</td><td>Within 3-4 years</td></tr>
<tr><td>1</td><td>Beyond 4 years</td></tr>
</table>
</td></tr>
</table>

4.4 Portfolio-balancing Factor Metrics and Scales

The Subcommittee considered several balancing factors to help in selecting a portfolio of high-ranking topics that best meets the overall objectives of the S-TEK Strategy and the mission and goals of the NPLCC. Descriptions of the factors and scoring scales were provided to all the evaluators and are described in Table 7. Balance across the three major ecosystems was also considered important, but did not require scoring by the evaluators.

Table 7. Metrics and scales for portfolio balancing factors

<table>
<tr><th>Portfolio-balancing Factors</th><th>Scale</th></tr>
<tr><td>Relevance of the topic to:
Each State (AK, WA, OR, CA)
British Columbia
Tribes/First Nations</td><td>
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>3</td><td>Highly relevant</td></tr>
<tr><td>2</td><td>Somewhat relevant</td></tr>
<tr><td>1</td><td>Not relevant</td></tr>
</table>
</td></tr>
<tr><td>Relevance of the topic to improving understanding or forecasts of these outcomes of interest:
Habitat quality
Species population health
Ecosystem function and services
Economic benefits from the landscape
Water quality and availability
Human health and security
Education and awareness of climate change</td><td>
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>3</td><td>Highly relevant</td></tr>
<tr><td>2</td><td>Somewhat relevant</td></tr>
<tr><td>1</td><td>Not relevant</td></tr>
</table>
</td></tr>
<tr><td>Geographic scale of the issue</td><td>
<table>
<tr><th>Score</th><th>Definition / Description</th></tr>
<tr><td>4</td><td>LCC-wide</td></tr>
<tr><td>3</td><td>Cross-ecoregions</td></tr>
<tr><td>2</td><td>Within a single ecoregion</td></tr>
<tr><td>1</td><td>Smaller than ecoregion</td></tr>
</table>
</td></tr>
</table>

4.5. Priority Topic Ranking

Evaluation criteria, portfolio balancing factors, and the metrics and their scales described above were incorporated into a second spreadsheet-based scoring tool for use by the Subcommittee. Using the spreadsheet, members each individually scored all topics (driver-resource pairs) within each category of topics they were evaluating.

After the individual Subcommittee members had completed the scoring of topics, those scores were combined (using a set of assumptions described below) to yield an overall "priority" score for each topic; and those scores were averaged across all individuals who scored the topic to give an overall priority score. Several sensitivity analyses were carried out, as described below.

In comparison to the impact matrix scoring, for which members scored all topics, having Subcommittee members score only those categories of topics where they had expertise and interest had the following effects:

- It reduced the scoring burden on individual Subcommittee members – members scored the topics in anywhere from one to four of the categories

- It reduced the opportunity for motivational bias to affect the relative scores across different categories (e.g., it was not likely that an individual would score topics of personal interest artificially high and topics not of personal interest artificially low, as they were scoring topics within a single category, or at least within categories that they have interests and expertise)

The design also raised some complications:

- Because everyone scored topics for which they have expertise and interest, scores could be "artificially" high across the board. This was not considered to be a serious concern given the intent to set relative priorities.

- There might be inadvertent systematic differences between categories, and it is very difficult to determine whether between-category differences result from biases or reflect genuine differences in priority.

The rank ordered list that resulted from this scoring exercise was intended to be the basis for Subcommittee discussions and decision-making, not the entire basis for the final selection of Priority Topics, and these complications were considered during those discussions

Scoring and Analysis Considerations

Several of the evaluation criteria required multiple metrics. Developing a single "importance" score required two types of assumptions or value judgments: (1) metrics related to a single criterion are combined to yield a single "score" for each criterion, and then (2) the scores for each of the four criteria are combined. (Portfolio balancing factors are not used in the ranking, but are used in the next step).

***Individual criterion scores**:* For "value of information," Subcommittee members provided a score for the value of additional information on a topic for each of six different types of management decisions the

NPLCC aims to support. The Subcommittee determined that it was appropriate to combine these six scores with equal weights, representing a judgment that it is equally important to provide support for any of the six decision types, and information that is highly valuable for multiple decision types is more valuable to the NPLCC than information that is highly valuable to only one type of decision.

The metrics for the "importance of LCC participation" were complex. Subcommittee members provided two scores: the first describing the size of the existing information gap, and the second describing their assessment of how critical LCC support is for addressing existing gaps. They provided these two scores for four different types of information and support that could be necessary, as listed above. The Subcommittee decided that for the purposes of this assessment, more weight should be given to the criticality of NPLCC participation than to the size of the information gap. Therefore, the second factor was weighted twice the first in creating a combined score for "importance of LCC participation.[3]" Based on the assumption that the NPLCC will provide or support the development of whatever types of information and support are most useful for a particular Priority Topic, the Subcommittee chose to use the maximum combined score across the four different types of information and support to represent the score for a topic on the "importance of LCC participation" criterion.[4]

Combining the criteria: The combinations above resulted in one score for each of the four evaluation criteria. Scores for "Timing of Need" did not provide significant discriminating power among topics: only two potential topics were identified for which members thought work could be delayed beyond four years. Since this is a four-year strategy, the Subcommittee decided to ignore the "timing of need" scores for the purpose of ranking topics for the S-TEK Strategy, but to use them in the annual planning process.

Of the remaining three criteria, the Subcommittee determined that the "value of information for decision-support" is the most important factor in determining the overall importance of a topic. To reflect that judgment they assigned that criterion twice the weight of the other two criteria, which were given equal weights. Several sensitivity analyses to these weighting factors are summarized in the next section.

4.6. Priority Topic Ranking Results

More than half of the Subcommittee members completed the ranking exercise for the 22 screened topics (n=23), each evaluating only those topics corresponding to their subject matter expertise (i.e. categories). Table 8 shows the number of individuals who scored each of the six categories.

[3] Sensitivity analyses were conducted exploring the relative weights on these two factors. As the two scores in questions were highly correlated, the combined score was relatively insensitive to the weighting.
[4] A sensitivity analysis was conducted using the average score (instead of the maximum score) across information and support types; changes were very slight.

Table 8. Distribution of responses to scoring exercise

Category	Number of driver-resource pairs in group	Number of responses
1 – Effects of ocean / coastal changes	6	8
2 – Effects on forests	4	9
3 – Effects of stressors on anadromous fish	2	7
4 – Hydrology, extreme events, freshwater habitats	4	7
5 – Effects on rivers and stream	4	7
6 – Effects of specific stressors on biological communities	2	5

The Subcommittee considered results of the scoring in several different ways:

- Ranking by the average combined score (Figure 5)
- Rankings by average score on each of the individual criteria (Figure 6)

The Subcommittee did not expect that the ranking exercise would yield results identical to those of the impact matrix screening exercise. While the impact matrix addressed primarily the strength and importance of ecological relationships, the ranking evaluation utilized explicit criteria, weighting, and scoring to address the role of LCC-level participation, timing, and strategic balancing of efforts across the ecoregion.

Average scores were high for all topics and criteria, but the full range of scores was utilized in almost all cases (i.e., within each category, there was at least one person who scored at least one topic within the category as “1” or “2” on each of the criteria). This provides some support for a conclusion that the high average scores reflected genuine high values (corresponding to their generally high scores in the impact matrix), and were not just an artifact of the way the metrics were defined.

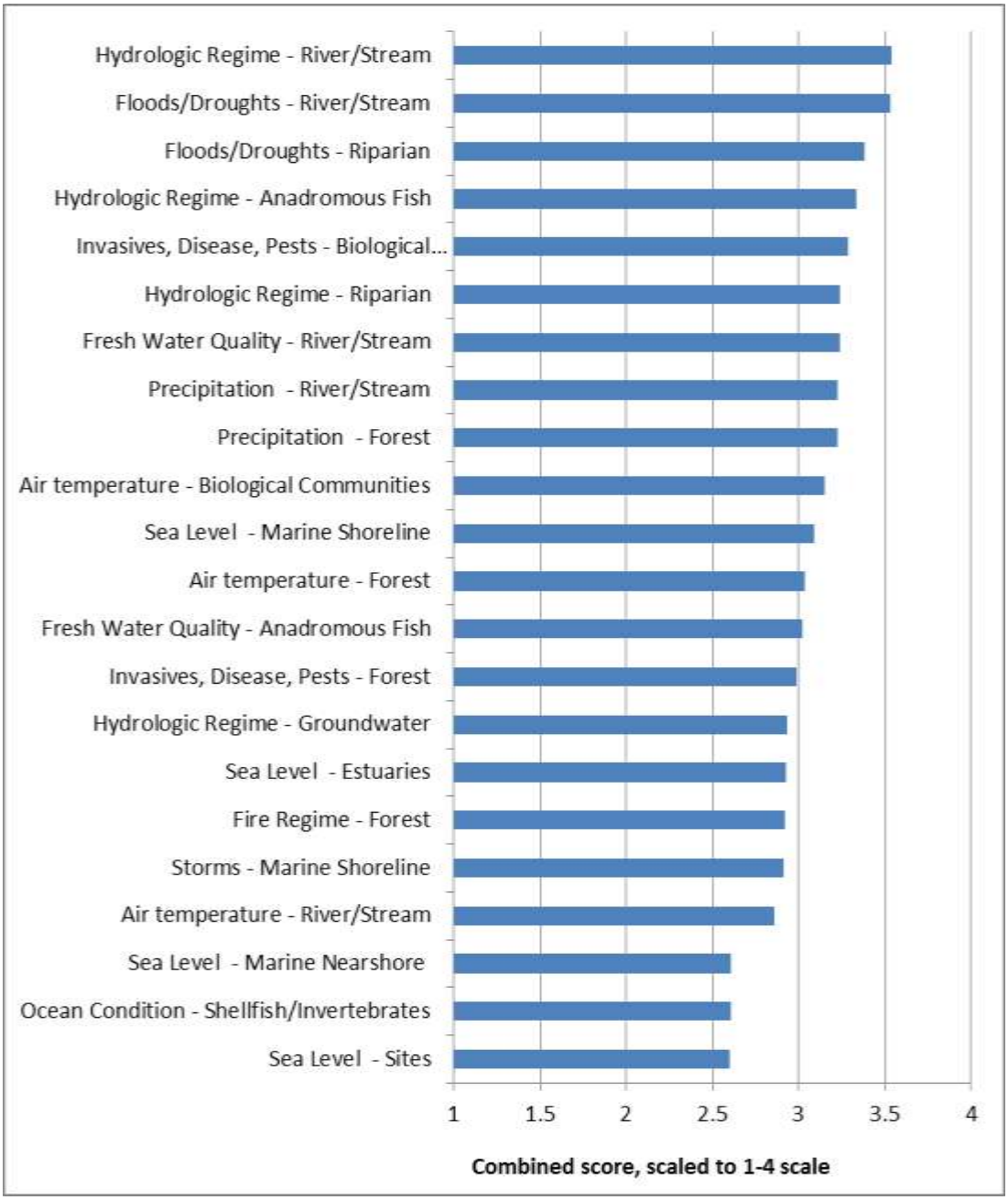

Figure 5. Results of Detailed Evaluation: Ranking of Topics by Combined Score

(Ranked by combined score)	Value of information for decisions	Breadth of Partneship interest	Importance of LCC-level participation
Hydrologic Regime - River/Stream	3.5	3.7	3.3
Floods/Droughts - River/Stream	3.4	3.7	3.5
Floods/Droughts - Riparian	3.5	3.3	3.3
Hydrologic Regime - Anadromous Fish	3.4	3.1	3.3
Invasives, Disease, Pests - Biological Communities	3.0	3.8	3.3
Hydrologic Regime - Riparian	3.2	3.3	3.3
Fresh Water Quality - River/Stream	3.2	3.3	3.2
Precipitation - River/Stream	3.2	3.6	2.9
Precipitation - Forest	3.0	3.6	3.3
Air temperature - Biological Communities	3.0	3.2	3.5
Sea Level - Marine Shoreline	3.2	2.9	3.1
Air temperature - Forest	2.8	3.3	3.2
Fresh Water Quality - Anadromous Fish	3.0	3.0	3.1
Invasives, Disease, Pests - Forest	2.9	3.1	3.0
Hydrologic Regime - Groundwater	2.7	3.0	3.3
Sea Level - Estuaries	3.1	2.5	3.0
Fire Regime - Forest	2.9	3.0	2.8
Storms - Marine Shoreline	3.0	2.8	2.9
Air temperature - River/Stream	2.8	3.0	2.9
Sea Level - Marine Nearshore	2.4	2.4	3.2
Ocean Condition - Shellfish/Invertebrates	2.7	2.3	2.8
Sea Level - Sites	2.6	2.1	3.0

Note: each column is color-coded from high scores in green to low scores in red. List is ordered by combined score, each column shows the ranking, in color coding, by the individual criteria

Figure 6. Ranking of Topics by Individual Criterion Scores

Sensitivity Analysis

The Subcommittee conducted a number of sensitivity analyses to test the robustness of the ranking by combined score. These analyses indicated that rank order was not particularly sensitive to modest changes in criteria weighting (Figure 7). In this figure, four alternative weightings are illustrated:

- The base case weights described above
- Equally weighting of the three criteria
- Base-case weights with the additional inclusion of the "timing of need" score in the combined score, and
- A case where the weight on the importance of LCC contribution is increase to equal that of the value of information for decision support (with lower weight on breadth of partnership interest)

	Base-case weights	Equal weights	Including "timing of need"	Increased weight on LCC contribution
Hydrologic Regime - River/Stream	3.5	3.5	3.4	3.4
Floods/Droughts - River/Stream	3.5	3.6	3.3	3.5
Floods/Droughts - Riparian	3.4	3.4	3.0	3.3
Hydrologic Regime - Anadromous Fish	3.3	3.3	3.2	3.2
Invasives, Disease, Pests - Biological Commun	3.3	3.4	3.1	3.3
Hydrologic Regime - Riparian	3.2	3.3	3.0	3.2
Fresh Water Quality - River/Stream	3.2	3.2	3.1	3.2
Precipitation - River/Stream	3.2	3.2	3.0	3.1
Precipitation - Forest	3.2	3.3	3.0	3.2
Air temperature - Biological Communities	3.2	3.2	2.9	3.2
Sea Level - Marine Shoreline	3.1	3.1	2.9	3.0
Air temperature - Forest	3.0	3.1	2.9	3.1
Fresh Water Quality - Anadromous Fish	3.0	3.0	2.9	3.0
Invasives, Disease, Pests - Forest	3.0	3.0	2.8	3.0
Hydrologic Regime - Groundwater	2.9	3.0	2.8	3.0
Sea Level - Estuaries	2.9	2.9	2.7	2.9
Fire Regime - Forest	2.9	2.9	2.7	2.8
Storms - Marine Shoreline	2.9	2.9	2.8	2.8
Air temperature - River/Stream	2.9	2.9	2.7	2.9
Sea Level - Marine Nearshore	2.6	2.7	2.5	2.7
Ocean Condition - Shellfish/Invertebrates	2.6	2.6	2.5	2.6
Sea Level - Sites	2.6	2.6	2.4	2.6

Note: each column is color-coded from high scores in green to low scores in red. List is ordered by combined score, each column shows the ranking, in color coding, by alternative criteria weightings

Figure 7. Sensitivity of Ranking to Alternative Criteria Weighting

5. Definition of Final Priority Topics

Considering the screened, ranked list of 22 potential topics, the Subcommittee noted that (1) topics in the freshwater ecosystem type dominated the top half of the rankings, and (2) some of those topics had substantial overlap and similarities. By consensus, several modifications where made to consolidate the list to ensure that the final set of Priority Topics made logical sense and satisfied the portfolio-level objectives of the NPLCC:

- Topics related to hydrology were combined into a single topic: **Topic A: Effects of Hydrologic Regime Shifts on Rivers, Streams, and Riparian Corridors.**
- The two main stressors affecting forests were combined to form a new single topic: **Topic B: Precipitation and Temperature Change Effects on Forests.**
- Topics related the effects of sea level changes and coastal storminess were combined into a single topic: **Topic C: Effects of Sea Level Changes and Storms on Marine Shorelines, the Nearshore, and Estuaries.**

- Two remaining topics from the top half of the ranked list were retained without modification: **Topic D: Hydrologic Regime Influences on Anadromous Fish**, and **Topic E: Invasive Species, Diseases, Pests, and their Effects on Biological Communities.**

Aspects of the topic **Air Temperature / Biological Communities**, which was 10th in the ranked list, were integrated into the other topics as a cross-cutting element. For example, biological communities within "Forests" are recognized as a critical component of forest health, and the effects of precipitation and temperature changes on those communities may be considered as part of that topic. Similarly, biological communities will be considered with the topic related to rivers, streams, and riparian corridors

6. Cross-walk of S-TEK Strategy Elements with Findings from NWF Focus Groups

As described in the S-TEK Strategy, the NPLCC funded the NWF to conduct surveys and convene a series of focus groups structured to identify challenges, opportunities, and potential strategic science and TEK needs and priorities. This process involved a broad group of more than 200 stakeholders, and resulted in a detailed report describing 23 "focal areas," each of which represents either an NPLCC-wide need, or an identified information or support need within a specific topical area.

Because of the aggressive schedule undertaken by the NPLCC to develop the S-TEK Strategy, the Subcommittee did not have final results from the NWF prior to its initial work to identify Priority Topics for the S-TEK Strategy. The Subcommittee both communicated with NWF throughout the process, and directly participated (as individual members) in the focus groups and other activities of the NWF. When preliminary NWF findings became available prior to final determination of the topics, the Subcommittee carried out a "cross-walk," comparing the topic rankings with the 23 focal areas identified NWF draft focus group report. This section summarizes that cross-walk.

6.1 High level needs identified by NWF

Through synthesis of the focus group results, NWF identified four types of climate-related needs that transcend specific ecosystems, habitats, or species. While typically identified within the discussion of a specific ecosystem, habitat, or species, these various types of information were identified as important for almost all such categories of topics. These were:

- New or different science, data, or information
- Decision-support systems and tools
- Capacity-building and collaboration
- Science communication and outreach

The Subcommittee addressed these findings in three ways: (1) the Priority Principles emphasize how the NPLCC will provide types of information not typically developed by the Partner entities, emphasizing the second two listed above over developing new or different science, data, or information; (2) the importance of providing the first three types of information and support listed above were explicitly

considered in the ranking of topics (as described in Section 4.3 above); and (3) annual implementation plans will consider both what types of information and support already exist, and what is being developed by others to help determine where NPLCC resources can be deployed to the largest benefit. The fourth type of information and support need - science communication and outreach – is the role of the NPLCC Strategy for Communication and Outreach, still under development.

The NWF report also identified several needs related specifically to Tribes and First Nations:

- Research to understand and assess climate change effects on the indigenous way of life
- Identify if and how to incorporate traditional ecological knowledge into western science and the NPLCC's work
- Provide capacity-building and decision-support to build and enhance the ability to address climate change effects

The NPLCC recognizes the importance of better understanding climate change effects on the Indigenous Way of Life and incorporating TEK, where desired by Tribes and First Nations, in the NPLCC's work. Tribes and First Nations are represented on the NPLCC Steering Committee and a Tribal and First Nations Committee is being formed and will provide additional direction to the NPLCC. Identifying actions the NPLCC can undertake to better understand and address how climate change's effects on natural and cultural resources affect the Indigenous Way of Life will be a high priority.

Providing capacity-building and decision-support to all partners, including Tribes and First Nations, is a focus of the NPLCC S-TEK Strategy and the mission and goals of the NPLCC. To explore the role of TEK in the work of the NPLCC, the NPLCC funded seven projects in 2012 (http://www.fws.gov/pacific/Climatechange/nplcc/docs/TEK project funding announcement_June2012.docx) spread throughout the NPLCC's geographic area. An eighth project was funded to assist with the identification of priorities related to natural and cultural resources important to Alaska Tribes that are impacted by climate change. Several of the projects will serve as case studies, assessing potential climate change effects on the Indigenous Way of Life. As these projects produce results, they may highlight new topics where information and support is needed or possibly identify needed revisions to the priorities included in the S-TEK Strategy.

6.2 Topical needs identified by the NWF

The remainder of the potential focus areas identified by the NWF generally related to specific ecosystems, habitats, or species. Several of these were combinations of topics and types of actions or activities to address the topic; generally they were more specific than the S-TEK Priority Topics. As described in the S-TEK Strategy, the goal of the Strategy is not to identify specific actions; rather it is to describe the set of principles and topics that will guide the Subcommittee and NPLCC during annual planning. The Subcommittee therefore noted that the additional detail in the NWF-identified focus areas will be useful in annual implementation planning. Table 10 identifies the NWF focus areas (using wording from the draft NWF report) and provides a summary of Subcommittee consideration.

Table 10: NWF focus areas and Subcommittee consideration

NWF potential focus area	Subcommittee consideration and disposition
Identified needs for coastal ecosystems and habitats	
Address potential changes to phenological relationships and food webs as a result of acidified and low-oxygen conditions	• Ocean conditions were a primary climate driver in the impact matrix; phenology was a secondary driver. It was not possible in the impact matrix to evaluation the interaction between primary and secondary drivers • The specific topic of ocean conditions and food webs/productivity was evaluated in the impact matrix but did not rise to the level of importance to be on the "short list." • The closest topic from the short list was ocean conditions / shellfish and invertebrates. That topic ranked #21 of the 22 topics on the short list and was not selected as a 2013-2016 Priority Topic.
Generate research results and maps to inform cost estimates and vulnerability assessments associated with altered coastal flooding regimes	**Priority Topic C: Effects of Sea Level Changes and Storms on Marine Shorelines, the Nearshore, and Estuaries**
Research, modeling, capacity-building, and decision-support in the intertidal zone, with a focus on wetlands and estuaries	• This focus area identifies two resources from the impact matrix (Marine Nearshore, which includes the intertidal zone, and Estuaries), and does not identify any specific climate-related driver of change • Effects of sea level rise on both of these resources were topic on the short list Could be considered within **Priority Topic C**
Research and capacity-building to characterize eelgrass and kelp habitats and identify priority areas	• Eelgrass and kelp habitats are included within the description of the Marine Nearshore resource; this topic does not identify any specific climate-related driver of change Could be considered within **Priority Topic C**
Identified needs for freshwater ecosystems	
Increase the resiliency of the hydrologic regime to climate change and other stressors	• Hydrologic regime changes were identified as a climate-related driver of change, rather than as a valued natural or cultural resource – associated resources were rivers, streams, and riparian corridors Captured by **Priority Topic A: Effects of Hydrologic Regime Shifts on Rivers, Streams, and Riparian Corridors**
Identified needs for terrestrial ecosystems and habitats	
Improved understanding of altered fog patterns and implications for coastal temperate rainforest hydrologic regimes	• Fog considered to be part of "precipitation" as a primary climate driver Effects of fog on the hydrologic regimes are included within **Priority Topic A**, and the effects of fog on temperate rainforest ecosystems are included within **Priority Topic B: Precipitation and Temperature Change and their effects on Forests**

NWF potential focus area	Subcommittee consideration and disposition
Research, scenario development, and decision-support to address whole-scale landscape change with a focus on changes in vegetation composition	• "Whole-scale landscape change" is not well defined, but the emphasis in the NWF report is on vegetative composition; vegetative composition is part of the definition of Forests and of Biological Communities in the impact matrix; numerous climate drivers might be considered. Topic is partially included in within **Priority Topic B**
Improved understanding of the relationship between fuels, fire, other disturbance regimes, and forest management implications	• Topic could include fire regimes, floods and droughts, and invasives, diseases and pests and climate-related drivers; and forests as the natural resource of interest. • Effects of changes in fire regimes on forests was on the short list but ranked #17 of the 22 topics; this relatively low ranking was attributed in part to the fact that concern and interest in fire regime changes differs across the NPLCC – it is much more important in the southern part of the NPLCC than in the northern part. Parts of this focus area related to "other disturbance regimes" can be addressed within **Priority Topic E: Invasive Species, Diseases, Pests and their effects on Biological Communities**
Research, data coordination, and decision-support to improve connectivity and refugia networks	Connectivity was identified as a valued resource within the impact matrix, but no topics related to connectivity were evaluated as sufficiently important to make the short list of topics. Actions related to connectivity could be considered in the annual work plans as it relates to any of the five selected Priority Topics (especially for **Topics A**, **B**, and **D: Hydrologic Regime Influences on Anadromous Fish**).
Support cross-boundary collaboration, public outreach, and development of guidance and scenarios in the Willamette Valley	Geographically-specific focus areas were not evaluated as potential focus areas for the S-TEK Strategy (case studies could be considered as part of annual implementation)
Identified needs for rare, endemic, vulnerable, and keystone species	
Research and decision-support to identify climate-resilient focal indicators and assess management options	This topic was not specifically addressed as part of any of the Priority Topics or Principles; however, it could be addressed during annual work plan development as appropriate for the Priority Topics. The detailed description in the NWF report suggests that the focus of discussion was on biological communities, particularly in terrestrial ecosystems which would fit best within Priority Topics B and E.
Research and capacity-building to assess vulnerability of Pacific salmon, other anadromous fish, and their habitat to climate change effect	**Priority Topic D**
Research and modeling for forage fishes	• Topic could include the effect of any (or all) climate-related drivers on forage fishes

NWF potential focus area	Subcommittee consideration and disposition
	• No Driver-forage fish topic was evaluated as sufficiently important to be on the short list of topics. The highest ranked related topic was #59; If the importance scores for all stressors-forage fish pairs are summed, impacts on forage fish were ranked #20 out of the 27 resources. Issues related to forage fishes may be included in the annual work plans under **Priority Topic C**
Modeling and decision-support for other key fish species	• Topic could include the effect of any (or all) climate-related drivers on "other key fish species:" Ground and rock fish were the only other specific fishes included in the impact matrix • No Driver-ground or rock fish topic was evaluated as sufficiently important to be on the short list of topics. The highest ranked related topic was #88; If the importance scores for all stressors-forage fish pairs are summed, impacts on ground and rock fish were ranked #27 out of the 27 resources. This topic may be considered in the annual work plans under **Priority Topics A and C**
Identified needs for invasive species, pests, pathogens, and disease	
Identify corridors for invasive species, pests, pathogens, and disease	Can be considered within **Priority Topic E**
Collaborate across ecosystems and specialties to address invasive species, pests, pathogens, and disease	**Priority Principle D: Promote and facilitate consideration of the connections and interactions between ecosystems** **Priority Topic E**

7. Support for Implementation

In the evaluation and ranking process described above, Subcommittee members provided information that was not used directly in the ranking and identification of NPLCC Priority Topics, but was identified as useful for annual implementation planning. Specifically, information on types of information and support needs will be useful for identifying potential project-level activities, and information on possible collaboration and leveraging opportunities will be useful in thinking about the timing and implementation of activities.

7.1 Types of Information and Support activities

Subcommittee members provided input on the importance of LCC participation in developing, or supporting the development of, different types of information (for each topic evaluated). The Subcommittee specified four different types of information or support that could be necessary (similar to the NWF high level needs noted above):

- Basic, fundamental, or "new" science, TEK, information, data or modeling (expanding or refining what's known about new or nascent areas of research; also information 'nobody' knows)

- Analyses, integration, and synthesis of existing data, datasets, models and information
- Coordination and sharing of related databases and data collection activities, research results, tools, and management lessons among partners, made accessible in a useful and useable format
- Understanding of and ability to use relevant information in decision-making (help in using information appropriately and effectively)

Evaluators then provided two "scores" for each type of information for each topic: how large is the gap between the amount of this type of information that is needed and the amount that exists or is being collected; and how critical is it that the NPLCC provide this type of information or support? While only the scores for the "most important" type of information or support were used in the ranking above, the Subcommittee recognized that a comparison of the importance of the four types of information and support could be useful for implementation planning.

Figure 8 shows summary level results: the number of topics for which each type of information or support was evaluated as being the most important for the NPLCC to develop or support). This supports Priority Principle B, which focuses more on facilitating coordination, collaboration, and capacity building, and on developing or assisting with tools to assist decision-makers than it does on developing new science and information.

However, the Subcommittee recognized that the specific needs are at least partly topic-dependent. The largest unaddressed gap for one topic may call for new or basic science; for another topic the greatest

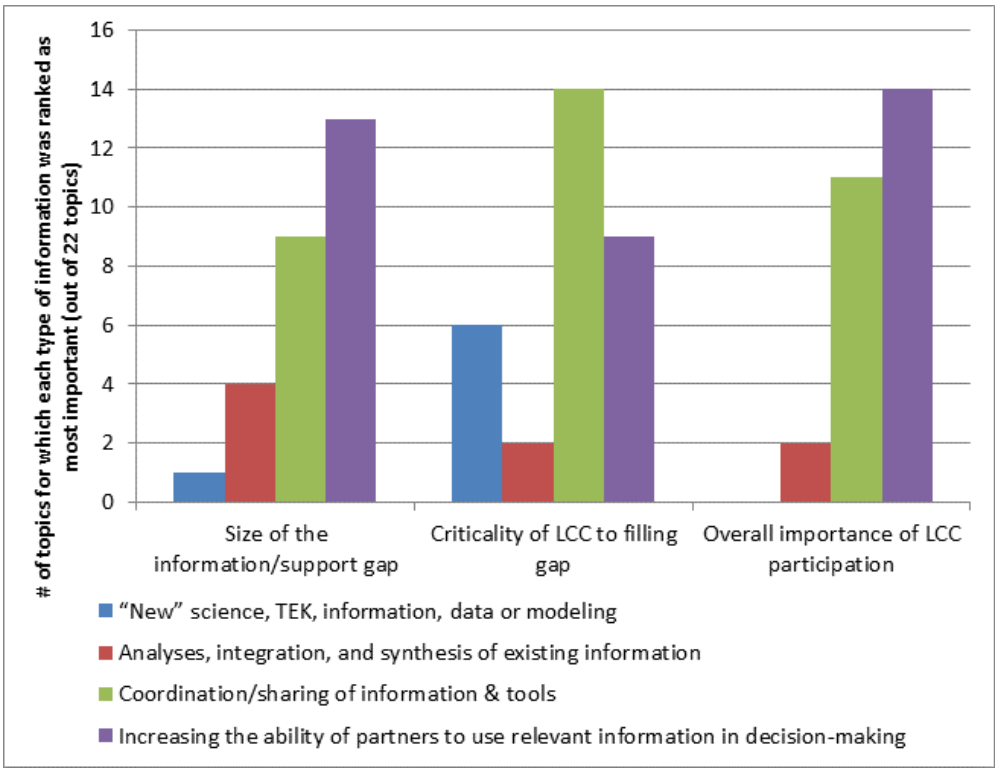

Figure 8. Importance of the Different Types of Information and Support

need might be for more effective use of existing information, and so on. Figure 9 shows the combined score for the importance of LCC support for each type of information for each of the Priority Topics, calculated by averaging across the scores for each individual topic included (or partially included) in the Priority Topic. While these average results are consistent with Figure 8, there were individual topics among the 22 that were evaluated in detail where "new science, information, or TEK" was ranked as that most important area for NPLCC focus. These evaluations will be revisited during the annual planning process, as the Subcommittee identifies specific project level actions that could be undertaken.

7.2 Opportunities for Leveraging

As part of the scoring for "timing of need," Subcommittee members were asked if they were aware of current activities relating to the topic that might present opportunities for the leveraging – that is, where NPLCC or partner resources could be combined with ongoing work to expand the usefulness of those activities to the partnership. For all but four of the topics, at least one such opportunity was identified, and for some topics upwards of a dozen potential opportunities were identified. The Subcommittee will review and expand, as necessary, on the identification of these opportunities as part of annual implementation planning.

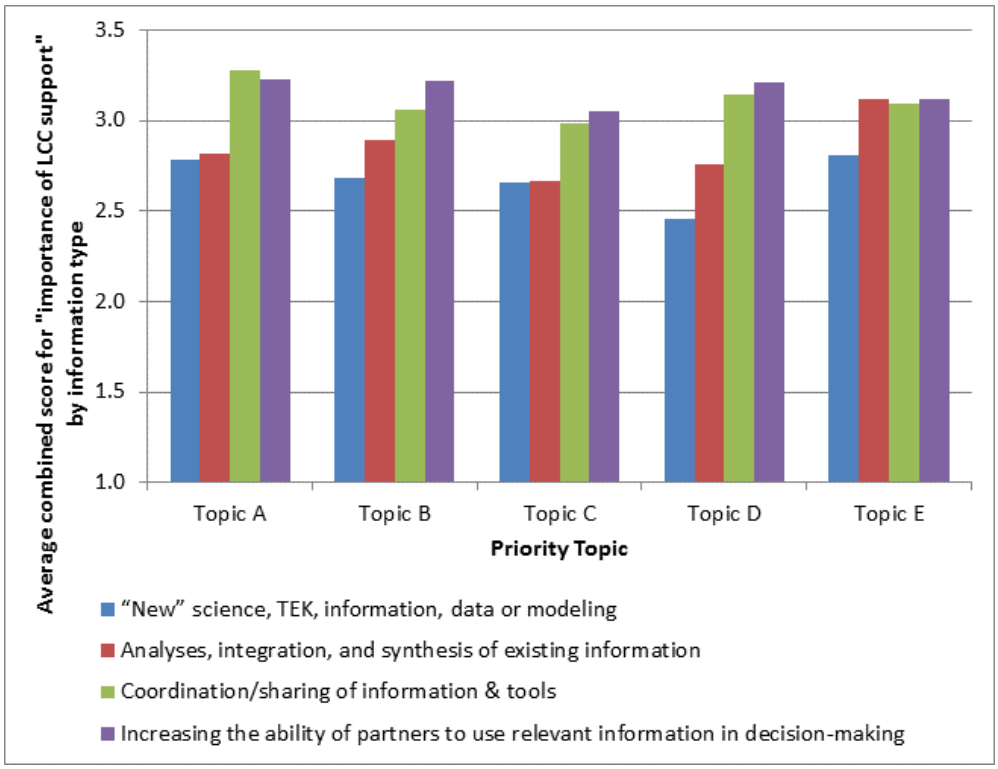

Figure 9. Importance of Different Types of Information and Support for each of the Priority Topics