Assessing the science of Puget Sound Recovery:
A summary of PSP's 2014-16 *Biennial Science Work Plan*

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The Puget Sound Partnership (PSP) coordinates the design and implementation of a regional plan for recovering the Puget Sound ecosystem. In this long-term endeavor, PSP is required by statute to produce, among other recurrent documents, a *Biennial Science Work Plan* (BSWP). Its primary purposes are fourfold: to assess how well ongoing research addresses decision-critical uncertainties relating to the recovery of Puget Sound; identify additional science needs for recovery; make recommendations for priority science actions in the coming biennium; and suggest how science can better support recovery. PSP's Leadership Council recently approved the third BSWP to be produced in this series, covering the 2014-2016 biennium. This article summarizes its salient features.

Part I: Assessment of ongoing and recently completed research

The previous (2011-13) edition of the BSWP had identified 48 so-called 'Priority Science Actions' (PSAs). These were topics, considered to be critical for recovery, for which unresolved questions warranted further study (for example, PSA 15 stated *Identify the key stressors on eelgrass*). To assess how well current research addresses these decision-critical uncertainties, an inventory was compiled of ongoing and recently completed research projects relating to Puget Sound recovery. The inventory, available as Appendix C to the original document, features 181 projects. Total expenditure on science was estimated to be in excess of $50 million, disbursed unevenly over seven years (2009-2016). About half of these projects (51%), and more than half of the funds (57%), derived from EPA's National Estuary Program, the remainder from other sources.

Where possible, each project was subjectively assigned to the most relevant of the 48 PSAs. Only two could *not* be assigned to a PSA. Many PSAs were well attended, with the largest number of projects (15) assigned to PSA 24: *Develop integrated monitoring and assessment of toxic chemical sources, exposure, and effects*. A few PSAs were assigned no projects, but further scrutiny showed that no PSA had been completely neglected. The assessment therefore found that ongoing research does broadly address recovery science needs and priorities, at least as they were stated in the 2011-13 BSWP. Taken together, these projects encompass the wide scope of scientific needs appropriate to recovering an ecosystem as large and complex as Puget Sound. It is intended that this inventory be used to summarize and synthesize knowledge, integrate strategies and actions, identify potential collaborators and groups of scientists working on related themes, and identify potential funding sources.

However, there were several areas in need of improvement. First, a more exacting assessment of how well projects met needs, and of unmet needs, was precluded. This was largely because, for most PSAs, goals were not sufficiently specified, nor were criteria that would indicate whether goals had been met. As a result, no PSA qualified for

elimination on grounds that it had been achieved, not for lack of scientific progress, but largely because PSAs were not specific enough to support a decision. Consequences are that, as currently written, the list of PSAs can more easily grow than shrink, and progress is hard to measure.

Second, while only 45% of projects in the inventory had been completed at the time of the assessment (March 2014), the imagined impact of at least 181 research projects focusing on such a diverse array of recovery priorities engenders hope that recovery gains will be forthcoming. However, it was not always clear how results of research would be applied directly to advance a given recovery strategy. Potential solutions are addressed in Part IV.

Part II: Description of recommended studies

To assess consensus about research priorities, recovery scientists and practitioners were once again invited to make recommendations (as they had for the 2011-13 BSWP). Of 265 who were invited, only 18 (6.8%) responded, with a total of 87 recommendations (Appendix E of the 2014-16 BSWP). A possible reason for the low response rate is that it was less than three years since scientists were previously polled about recovery priorities, and perceptions may not have changed enough to motivate responses. The resulting sample size was in any case too small to draw conclusions about priorities based on consensus.

Even so, several points are worth noting. First, none of the recommendations could *not* be assigned to an existing PSA, or Action Agenda Sub-Strategy. This implies that existing lists of PSAs and Sub-Strategies are stable, that the effort to define the scope of recovery topics for Puget Sound has been inclusive, and the outcome is robust, at least at coarse level.

Second, numbers of recommendations assigned to each Action Agenda Sub-Strategy in the 2011-13 and 2014-16 Biennial Science Work Plans were positively correlated (see Table 5 of the original report). Correspondence between the two lists is of interest because, all else being equal, it would result if on both occasions responses represented a random sample from the community of recovery scientists, whose preferences had not changed much in the interim. This method of generating recovery science priorities may better reflect the make-up of the recovery science community than actual research priorities. An alternative approach to identifying decision-critical research priorities is outlined below in Part IV.

Part III: Research priorities for the next biennium

Additional research recommendations were gathered from reports prepared in recent years that address topics highlighted by the Science Panel in the 2011-13 BSWP. They qualified for inclusion by being products of consensus among experts, and by being documented in some way. They included:

- A subset of 11 recommendations from 19 in the report by the 2012 *Blue Ribbon Panel on Ocean Acidification*;

- 7 recommendations from a 2013 report on *Ecosystem-based Management of Forage Fish in Puget Sound*;
- 24 research priorities from the 2013 strategic plan of the *Salish Sea Marine Survival Project* on salmon;
- 42 research gaps from a 2013 report of a workshop to identify research gaps in the social sciences;
- 56 monitoring gaps identified by work groups of the Puget Sound Ecosystem Monitoring Program (PSEMP).

No process currently exists for prioritizing recommendations for research relating to Puget Sound recovery, whatever their provenance. Accordingly, no attempt was made to select or rank recommended priorities for research. Prospective sponsors of recovery science in Puget Sound should view these recommendations as relevant and timely, all backed by the credibility of scientists currently working on ecosystem recovery in Puget Sound.

Part IV: Recommendations for improvement

According to the latest *State of the Sound* report (2013) most indicators of Puget Sound's vitality (so-called 'Vital Signs') have not advanced much, if at all, towards their recovery targets, and some, such as orcas, have lost ground. Progress may be slow because capacity and resources are spread too thinly over too many targets and across too large an area for recovery gains to be detectable. Even if this is true, in complex systems like Puget Sound, narrowing the scope of the recovery strategy to a feasible yet functionally effective number of targets turns out to be one of the greatest challenges of all. This is because the number of potential targets is large, many of them interact with each other, and much of the information is lacking by which targets could be ranked by potential to yield greatest recovery gains.

This assessment cited several additional checks on recovery progress in Puget Sound: research goals are insufficiently specified, the effectiveness of actions inadequately measured, and too often it is left implicit how results from research should influence or be applied to recovery. These are all symptoms of a more fundamental reason for slow progress towards recovery: that adaptive management (AM) is difficult to apply at the ecosystem level. No approach to recovery guarantees success, but, more than any other, AM increases the likelihood that progress can be made under uncertainty. If everything was known about how to achieve a given recovery target, the process would resemble, say, construction of a bridge. For ecosystem targets, however, it is rarely the case that enough is known, and no new knowledge is needed, to attain a recovery goal. For most, there is uncertainty about how outcomes are affected by natural processes, how these are impacted by humans, or how restoration and protection actions bring about recovery. AM tackles uncertainty head-on by ensuring that we learn by experience. If progress is elusive, AM helps us understand *why*, and advances in understanding help to justify continued funding.

In Puget Sound, AM was nominally adopted as the default approach, but has been applied in a patchy and incomplete manner, partly because of insufficient resources. The Science Panel endorses application of AM, and specified how it should be supported in two ways.

Implementation Strategies

Initial emphasis should be on completion of 'implementation strategies' for each recovery target. These would distill existing concepts about how recovery should be achieved: the mechanistic theories, causal pathways, and actions by which recovery targets are expected to be met. In this context, therefore, the term 'implementation strategy' includes and entails the integration of science to address critical uncertainties.

Recovery Groups

It was further recommended that implementation strategies for each recovery target be designed by a separate 'recovery group'. The Puget Sound recovery community of scientists, managers, policy makers and practitioners is large and well versed in contributing to advances by consensus of expert opinion. Most targets are already attended to by groups operating in varying degrees of formality. The emphasis on creating implementation strategies by separate recovery groups is intended to meet several needs. One is to integrate science and policy more directly into the practice of recovery. A second is to specify strategies (that can be supported by policy) for attaining each recovery target, while implementing a style of adaptive management that is more informative about effectiveness and progress. The third need is to find additional ways to advance the research agenda to define decision critical science for recovery, given the wide array of what are essentially equal priorities, and in the face of shrinking budgets. The only way to achieve this exacting agenda is to spread the task of planning recovery strategies and guiding their implementation among groups of practitioners with the requisite experience and resources.

Used in this way, implementation strategies should address and resolve many of the difficulties relating to identification and selection of decision-critical research that were highlighted in Parts I-III of this report. Once an implementation strategy is designed and documented it becomes possible to separate layers showing the junctures at which (1) research is needed to resolve a critical uncertainty (including models and social science), (2) monitoring is needed to assess effectiveness of actions, (3) policy changes are required; (4) costs can be estimated to assess cost-effectiveness, and (5) time will be needed for social and ecological processes to deliver expected outcomes. In this way, not only are the essential elements of recovery (science, policy, monitoring, etc.) featured, but their integration and interactions can also be represented. For any given time and purpose (such as the preparation of a BSWP), the list of research priorities can be drawn up simply by combining the 'research layers' from each implementation strategy. The list of monitoring and policy priorities would be similarly derived. It becomes at least conceivable to estimate and compare the cost and cost-effectiveness of alternate paths and actions, order actions into a logical time frame, and expose

common and conflicting goals within and among strategies. To date, this level of integration among recovery strategies has yet to be achieved.

Related links:

Biennial Science Work Plan for 2014-2016: An assessment of priority science for restoring and protecting Puget Sound, with research priority recommendations for the next biennium

http://www.eopugetsound.org/articles/biennial-science-work-plan-2014-2016-assessment-priority-science-restoring-and-protecting

An inventory of scientific research associated with Puget Sound recovery from 2011-2013

http://www.eopugetsound.org/articles/inventory-scientific-research-associated-puget-sound-recovery-2011-2013