

**Addendum #3**

**To**

**RFQQ 2013 – 83**

**Multi-Scale Soundwide Pressure Assessment**

**DRAFT**

## **2013 Puget Sound Partnership Pressure Taxonomy Working Paper**

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### **Introduction**

In this document we describe the array of pressures, both human activities and natural events, considered by the Puget Sound Partnership (PSP) to be those most directly influencing Puget Sound ecosystems and the ecosystem's contributions to human health and well-being. We present a taxonomy of pressures, as developed and revised by PSP and its partners and informed by related projects and publications over the past three years, and describe a process for using the taxonomy to describe pathways of effect linking pressures to ecosystem components. We also describe the ways in which this 2013 version of the taxonomy differs from the first PSP Soundwide "threat" taxonomy published as a technical memorandum to the 2009 State of the Sound (SOS) report (Neuman, 2009) along with an overview of information and processes that have informed 2009 to 2013 revisions to the taxonomy.

The overall intent of this document is to share PSP's articulation of Soundwide pressures in order to (i) explain the pressure classes PSP and some partners have used to guide recovery planning in the period of time from publication of the 2009 SOS to the 2012 update of the Action Agenda, and (ii) express PSP's

current classification of pressures in a sufficiently detailed way so that others – including forthcoming PSP projects and projects led by other entities -- can understand the evolution of the taxonomy and its current components as they decide how to use, build from, adapt or move away from the PSP 2013 pressure taxonomy. More specifically, this document is intended to

- provide a common taxonomy of pressures that can be used by PSP and its partners working on conservation and ecosystem recovery projects at soundwide or smaller geographic scales. The taxonomy is intended to be used ‘as is’ or adapted to fit the needs of specific projects.
- describe differences and similarities between the 2013 pressure taxonomy and previous iterations of the taxonomy. Previous iterations include the 2009 Threat Taxonomy (S.O.S. 2009), unpublished revisions to the taxonomy in 2011 that were used to inform development of a common framework for Chinook recovery (RITT 2013), and the June 2012 Revised Threat Taxonomy (Action Agenda, 2012) used for evaluation and rating of Action Agenda sub-strategies as part of the 2012 Action Agenda update. This crosswalk to previous versions of PSP and other Soundwide taxonomies is intended to facilitate information sharing across and within projects.
- provide background information for development of forthcoming Puget Sound ecosystem pressures assessments.

The primary audiences for this pressure taxonomy include PSP staff and all partners working on conservation, ecosystem recovery and adaptive management at soundwide and smaller scales.

For PSP staff and projects, this document is intended to

- provide a status update on pressure classification and soundwide ratings
- provide a common pressure taxonomy for use in PSP-led projects related to planning and evaluating ecosystem recovery efforts
- support the Local Project Implementation Program and coordination of forthcoming watershed-scale planning (e.g., development of salmon recovery adaptive management and monitoring plans) and LIO-scale pressure, strategy and action prioritization processes
- inform development and implementation of the Puget Sound Ecosystem Monitoring Program (PSEMP)
- inform and support the next Action Agenda update
- inform development of a pressure filter for PSP’s performance accountability system
- inform and support evaluation and revisions to PSP’s Vital Sign indicators and 2020 recovery targets

For local partners, including salmon recovery Lead Entities, LIOs, and any other partners working on ecosystem recovery, this document is intended to

- provide a common framework for describing pressures to support the development of effective, results-based adaptive management plans, programs and monitoring of ecosystem condition and management effectiveness
- provide a common framework for describing pressures to support improved communication and collaboration across projects and partners
- support roll-up of local information (e.g. priority strategies and actions) to the soundwide scale
- support analyses of pressure status and the effectiveness of management actions across projects

For forthcoming pressure assessments at the soundwide and LIO scale, development of prioritization and decision-support tools, and other science initiatives, this document is intended to

- provide a status update on approaches to pressure classification and soundwide ratings in Puget Sound for the PSP Science Panel and other scientists and partners
- support identification of gaps in understanding and priority research needs related to sources of stress, stressors, and impacts to Puget Sound ecosystems, species and human well-being

Companion documents to this working paper include spreadsheets (also summarized in the attached appendices) and a Miradi file including pressure network diagrams for each of the 29 pressure classes.

Links to the working paper and companion documents are available at

<https://sites.google.com/a/uw.edu/puget-sound-open-standards---temporary-share-site/documents/pressures-taxonomy> .

**\*\*The 2013 Pressure Taxonomy as presented here has not yet been formally reviewed or adopted by PSP. A formal review process for this document is currently being defined.**

**\*\* This is an evolving taxonomy. The authors expect that PSP staff and partners will continue to refine the taxonomy as needed to support Puget Sound ecosystem recovery efforts.**

## Why is a Pressure Taxonomy Useful?

Puget Sound ecosystems, species and human wellbeing are affected by both natural events and human activities. Broadly, these activities and events that ultimately effect change in the ecosystem via a variety of pathways of effect can be called “pressures”, or “threats”. In recognition of the fact that both human-derived activities and natural events can have both positive and negative effects, and do not always pose a risk to Puget Sound ecosystems and people, PSP refers to these activities and events as “pressures” rather than “threats”.

In its conceptual models of the Puget Sound ecosystem and of ecosystem recovery efforts, PSP identifies key components of the ecosystem and the pressures that directly threaten these components. The pressure taxonomy is intended to support recovery efforts by improving the ability of practitioners, managers, scientists and decision-makers to communicate, coordinate and collaborate more effectively within and across projects. Use of a common taxonomy will enable the Puget Sound ecosystem recovery community to

- compare pressure reduction strategies, actions and outcomes across multiple geographies
- assess the effectiveness of management actions targeted at reducing pressures and improving ecosystem health across multiple projects and geographies
- roll up subregional information on pressures and management actions to larger scales (e.g. from watershed scale to Puget Sound Basin scale)
- access and make better use of scientific and other information developed by partners working in other geographies

The taxonomy is intended to serve as a starting point for using a common language to describe the

multiple pathways of effect of pressures to Puget Sound ecosystems. Depending on the focus and scale of a project, the nomenclature and relationships described in the taxonomy could be applied directly. Alternatively, the names and descriptions in the taxonomy could be adapted to meet the needs of a particular project and its stakeholders. For example, rather than addressing Marine Shoreline Infrastructure as a single pressure class, resource managers in a local jurisdiction might find it useful to break this single pressure class into 2 or more pressures addressing shoreline armoring and overwater structures separately, or addressing infrastructure associated with residential development and commercial development separately. Ultimately, if all Puget Sound ecosystem recovery partners are able to reference the common taxonomy presented here, we, as a region will increase our capacity to assess risks to Puget Sound ecosystems and develop more effective approaches to managing and reducing threats to the Sound.

### **Puget Sound Pressure Taxonomy History**

The taxonomy presented here builds on a number of previous efforts to describe and classify pressures, or threats, to Puget Sound ecosystems. In 2008 PSP led a demonstration project to describe and characterize threats to Puget Sound ecosystems and species at the scale of the action area. For this demonstration project a team of scientists used Driver-Pressure-State-Impact-Response (DPSIR) models to articulate pathways of effect for a small set of high priority threats (Ruckelshaus et al, 2008). In 2009, PSP developed a soundwide threat taxonomy including 26 threat classes and ranked their impacts to Puget Sound ecosystems (SOS 2009) at the soundwide scale. In 2011, the first Puget Sound Science Update included a chapter on high priority threats to Puget Sound (Pearson et al 2011), the organization of which was informed by the 2009 PSP Threat Taxonomy. In 2012, an expert workgroup was convened to revise the 2009 threat classes to support rating the ecological importance of sub-strategies in the 2012 Action Agenda update. A summary of revisions to the 2009 Threat Taxonomy as informed by these projects and processes is included in Appendix A.4. Finally, the Chinook Recovery Implementation Technical Team (RITT) has been working since 2009 and recently published a common framework for Chinook recovery, *Puget Sound Chinook Salmon Recovery: A Framework for the Development of Monitoring and Adaptive Management Plans* (RITT, 2013). The Chinook pressure taxonomy within this framework document informed and is consistent with the taxonomy presented here.

### **Additional Considerations**

*To be developed further...*

Pressures as classified here represent negative pressures to Puget Sound ecosystems. These pressures are often also beneficial to humans (e.g. development, recreation, animal harvest, timber harvest, agriculture). As such, recovery strategies and actions intended to reduce the negative impacts of pressures on ecosystems can often have negative impacts or unintended consequences for people. These trade-offs and unintended consequences of pressure-reduction actions are not addressed within this taxonomy but will need to be carefully considered in any recovery planning effort. The inclusion of stressors in this taxonomy (e.g. habitat conversion or habitat degradation) in addition to sources of pressure (e.g. development) are intended to help focus discussions around pressure reduction strategies

on those specific aspects of the pressure that are causing the problems (e.g. habitat loss due to development).

Temporal characteristics of pressures are not discussed here but should be considered when applying the taxonomy in any ecosystem recovery effort. A historic pressure may be responsible for a stressed condition even if the pressure is no longer occurring. For example, legacy contaminants will need to be addressed in many places even where the source of those contaminants has already been removed.

The geographic occurrence of sources of stress (pressures) and stressors is a key determinant of the scope, severity, persistence, and irreversibility of the stress exerted in a system. An assumption in this taxonomy is that information about spatial characteristics of pressures must be described within the context of a given ecosystem recovery effort.

*To be developed further...*

### **Next Steps**

The Puget Sound pressure taxonomy is an evolving resource. The authors expect that PSP and partners will continue to refine the taxonomy to meet the needs of the many ecosystem recovery efforts in the region. Near-term forthcoming work that will improve pressure taxonomy and utility for Puget Sound recovery efforts includes

- 2013-2014 soundwide pressure assessment commissioned by PSP, the Science Panel and the Marine-Nearshore Lead Organization
- 2013-2014 development of 16 Chinook watershed-scale monitoring and adaptive management frameworks
- LIO-scale prioritization of near-term actions for the 2014 Action Agenda update

## 2013 Pressure Taxonomy

This section presents the complete pressure taxonomy and describes the different types of elements included in the taxonomy.

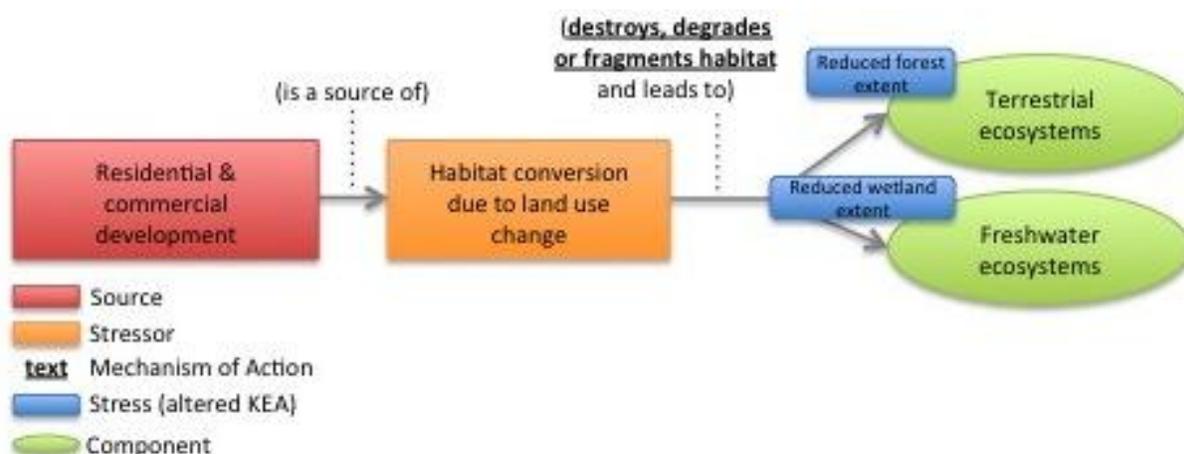
### What do We Mean by “Pressures”?

Puget Sound ecosystems, species and human wellbeing are affected by both natural events and human activities. Broadly, these activities and events that ultimately effect change in the ecosystem via a variety of pathways of effect can be called “pressures”, or “threats”. In recognition of the fact that both human-derived activities and natural events can have both positive and negative effects, and do not always pose a risk to Puget Sound ecosystems and people, PSP refers to these activities and events as “pressures” rather than “threats”.

The pressure taxonomy is hierarchical and includes three levels of information: pressure categories, pressure classes, and stressors. Pressure categories and classes can broadly be through of as *sources* of stress, while the stressors are the most proximate actors on the ecosystem. Most of the pressure classes in the PSP taxonomy represent *sources* of stress (e.g. development) that act on ecosystems via one or more *stressors* (e.g. land conversion or pollution). In very few cases, a pressure class also represents a *stressor* (e.g. derelict fishing gear). The elements of the pressure taxonomy and the relationship between elements, including the mechanisms by which stressors act on ecosystems, are discussed in more detail in the following sections.

### Using the Puget Sound Pressure Taxonomy to Describe Pathways of Effect

This section provides descriptions of the different types of elements in the taxonomy and presents an example of how the elements can be combined to describe pathways of effect, or the pathways by which sources of stress act on ecosystem components. For example, in a watershed that identifies development as a primary source of stress on one or more ecosystem components, a conceptual model of one pathway of effect for the pressure *Residential and Commercial Development* might look as follows:



Reading from left to right, this complete pressure pathway diagram says that *residential and commercial*

*development is a source of habitat conversion due to land use change (stressor) that leads to the destruction or fragmentation (mechanism of action) of terrestrial and freshwater ecosystems (focal ecosystem components). The primary ecological effects identified in this pressure pathway are *reduced forest extent* and *reduced wetland extent (stresses)*.*

A clear description of the pathways by which pressures act on ecosystem components serves multiple purposes. First, it provides a framework for assessing and prioritizing risks to ecosystem components. A clear description of sources, stressors and their mechanisms of action supports an assessment of the extent and severity of pressures, or threats, to the ecosystem across multiple scales. Second, it provides a framework for developing and prioritizing strategies and actions. Specifically, clear articulation of assumed pathways of effect highlights opportunities for action. For example, if multiple sources are acting through a single stressor, it might be useful to consider development of strategies and actions focused directly on reducing the direct impacts of the stressor, in addition to strategies focused on reducing the sources of pressure. Alternatively, if a single source is acting on the ecosystem via multiple stressors it might be most effective to focus strategies and actions at the level of the source in order to effect reduction in all associated stressors.

The rest of this section walks through the process of building this type of conceptual model using elements of the pressure taxonomy. In the example, we build the model from left to right, identifying sources first and describing impacts to ecosystem components (stresses) last. However, it is possible and desirable to build these diagrams in whatever direction makes the most sense in a given application. For example, if a lot of information exists about the relationship between a stressor and some ecosystem components, it might make more sense to start with the stressor-component relationships and identify likely sources of this stressor as well as specific impacts to ecosystem components later.

## **Elements of the Pressure Taxonomy, their Relationships and their Impacts**

### ***Pressure Classes (aka Sources)***

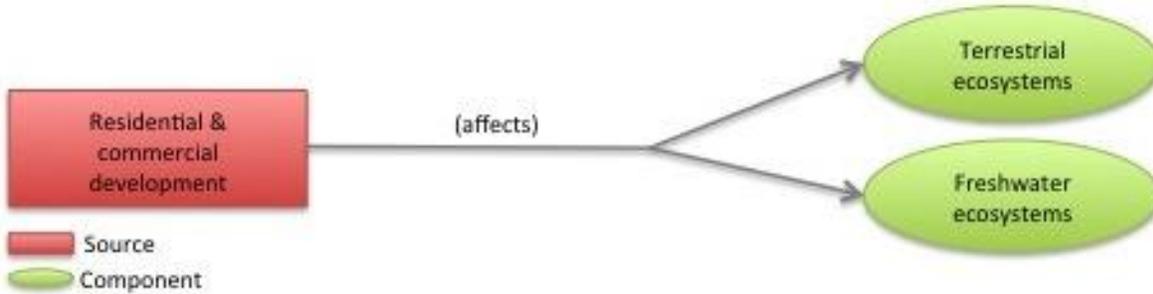
At the highest level, the taxonomy includes 29 pressure classes grouped into ten pressure categories (Table 1).

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. <b>Residential &amp; Commercial Development</b> <ol style="list-style-type: none"> <li>1.1 Residential &amp; Commercial Development</li> </ol> </li> <li>2. <b>Agriculture &amp; Aquaculture</b> <ol style="list-style-type: none"> <li>2.1 Agriculture</li> <li>2.2 Livestock Grazing</li> <li>2.3 Fin Fish Aquaculture</li> <li>2.4 Shellfish Aquaculture</li> <li>2.5 Timer Harvesting</li> </ol> </li> <li>3. <b>Energy Production &amp; Mining</b> <ol style="list-style-type: none"> <li>3.1 Energy Production &amp; Energy Emissions</li> <li>3.2 Mineral &amp; Gravel Mining</li> </ol> </li> <li>4. <b>Transportation &amp; Service Corridors</b> <ol style="list-style-type: none"> <li>4.1 Transportation &amp; Service Corridors</li> <li>4.2 Dredging &amp; Dredged Materials</li> </ol> </li> <li>5. <b>Biological Resource Use</b> <ol style="list-style-type: none"> <li>5.1 Animal Harvesting (Aquatic)</li> <li>5.2 Animal Harvesting (Terrestrial)</li> </ol> </li> <li>6. <b>Human Intrusions &amp; Disturbances</b> <ol style="list-style-type: none"> <li>6.1 Recreational Activities</li> <li>6.2 Military Exercises</li> <li>6.3 Derelict Fishing Gear</li> </ol> </li> </ol> | <ol style="list-style-type: none"> <li>7. <b>Natural System Modifications</b> <ol style="list-style-type: none"> <li>7.1 Dams</li> <li>7.2 Culverts</li> <li>7.3 Freshwater Levees &amp; Floodgates</li> <li>7.4 Marine Water Levees &amp; Tidegates</li> <li>7.5 Freshwater Shoreline Infrastructure</li> <li>7.6 Marine Shoreline Infrastructure</li> </ol> </li> <li>8. <b>Invasive &amp; Other Problematic Species</b> <ol style="list-style-type: none"> <li>8.1 Invasive Species (Aquatic, Terrestrial)</li> </ol> </li> <li>9. <b>Pollution</b> <ol style="list-style-type: none"> <li>9.1 Runoff from the Built Environment</li> <li>9.2 Industrial, Domestic &amp; Municipal Wastewater</li> <li>9.3 Onsite Sewage Systems (OSS)</li> <li>9.4 Combined Sewer Overflows (CSOs)</li> <li>9.5 Toxics &amp; Legacy Contaminants</li> <li>9.6 Oil &amp; Hazardous Spills</li> </ol> </li> <li>10. <b>Water Withdrawals &amp; Diversions</b> <ol style="list-style-type: none"> <li>10.1 Water Withdrawals &amp; Diversions</li> </ol> </li> </ol> |
|---|---|

**Table 1. The 29 pressure classes and ten pressure categories in the PSP 2013 Pressure Taxonomy**

Most of the 29 pressure classes represent sources of stress. In effect, the taxonomy represents a classification of sources, with nested taxonomies of stressors and associated mechanisms of action and stresses used to further define a source’s specific pathways of effect on Puget Sound ecosystems. Sources of stress are not the most proximal actors on ecosystem components but rather act on the ecosystem via one or more stressors, or agents. For example, the pressure *Residential & Commercial Development* acts directly on ecosystem components via habitat conversion and pollution (air, noise, and light), as well as indirectly via increasing the need for other pressures, or sources of stress, including *Transportation & Service Corridors* and *Runoff from the Built Environment*.

To begin building a conceptual model describing the relationship between development pressures and ecosystem components we must first identify the ecosystem components that are affected by development, for example, *terrestrial* and *freshwater ecosystems*. Pressure-component relationships are purposefully not included in this taxonomy. All ecosystem conservation or recovery efforts must first define these relationships as they currently exist within the scope of the project. Pressure-component relationships will likely be similar around Puget Sound but all pressure-component pairs are not relevant to all regions of Puget Sound. It is critical that each project define the pressure-component relationships most critical within the project geography. These relationships can be illustrated with a pressure pathway diagram using an Open Standards conceptual model approach and Miradi-style graphics as follows:

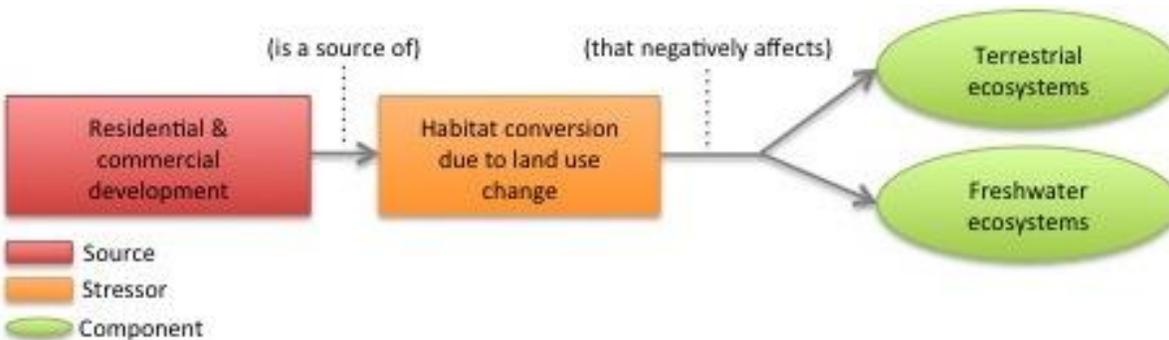


Reading left to right, this pressure pathway diagram says that *development* is a source of stress on *terrestrial* and *freshwater ecosystems* (components). Next, the watershed identifies stressors and mechanisms of action that describe the pathways by which the source (e.g. development) affects the ecosystem components (e.g. freshwater ecosystems).

### Stressors

All sources of pressure act on, or effect change in Puget Sound ecosystem components via one or more stressors. For example, *residential and commercial development* (source) poses a direct threat to ecosystems and ecological processes due to problems associated with *land conversion* and *air pollution* (stressors). Stressors can also be thought of as the most proximal actors on systems, or the specific structures, compounds and activities that directly impact habitats, species and people.

Here we present a common taxonomy of stressors (Table 2) that can be paired with the pressure classes to define cause and effect pathways linking sources of pressure to stressors and ultimately to their direct effects on ecosystem components and attributes of interest. For example, the below diagram builds on the source-component model developed in the previous section and adds a stressor to further define a pathway by which the source (development) acts on the ecosystem:



Reading from left to right, this pressure pathway diagram says that development is a source of habitat conversion (stressor) that negatively affects terrestrial and freshwater ecosystems (components). To further clarify how the stressor is affecting components, the watershed can describe the mechanism(s) of action and the effects (or stresses) to ecosystem components.

Table 2 presents a taxonomy of common stressors in Puget Sound. See Table A.2 for a complete list of stressors with definitions and additional information about their primary sources and common ecological effects, or stresses to ecosystem components.

**Table 2. The 33 stressors comprising the second level of the PSP 2013 Pressure Taxonomy**

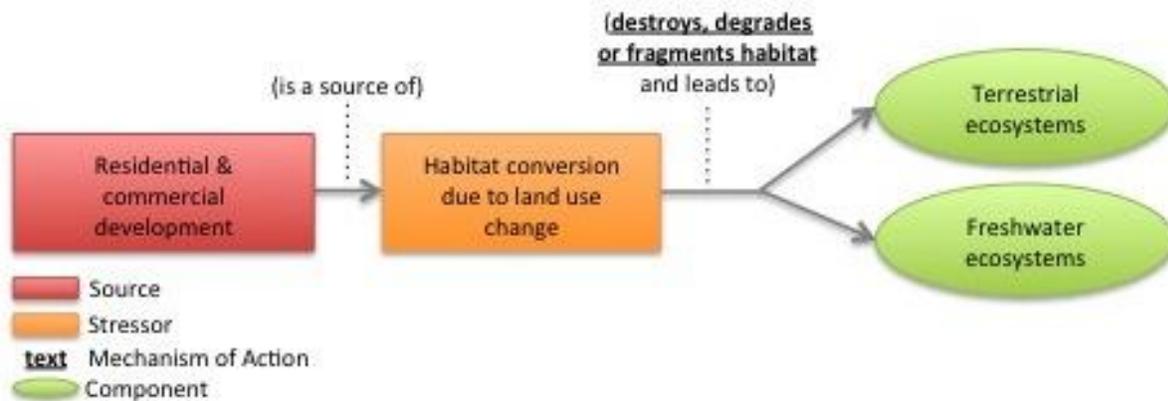
- a. Bycatch (unintended harvest)
- b. Derelict fishing gear and vessels
- c. Disease introduction
- d. Fish passage barriers
- e. Habitat conversion due to human land-use change
- f. Habitat degradation
- g. Defoliation
- h. Habitat destruction due to altered hydrology
- i. Harvest
- j. Hydromodification - altered volume and timing of runoff
- k. Hydromodification - ditching
- l. Hydromodification - flow regulation
- m. Hydromodification - structural barriers to water, sediment, debris flow
- n. Hydromodification - water diversion
- o. Hydromodification - water extraction
- p. Increased competition - due to increased native species
- q. Increased competition - due to increased non-native species
- r. Increased predation - due to overwater structures and shading
- s. Increased predation - due to increased native or introduced species
- t. Introduced genetic material
- u. Overwater structures
- v. Pollution - air pollution
- w. Pollution - atmospheric deposition
- x. Pollution - pesticide application
- y. Pollution - munitions testing
- z. Pollution - release of legacy toxics
- aa. Pollution - toxics, nutrients, sediment, pathogens in water
- bb. Pollution - underwater bombs & testing
- cc. Shoreline hardening
- dd. Soil compaction
- ee. Species disturbance
- ff. Toxic spills
- gg. Toxics in environment

In some cases, a lot more is known about specific stressors than sources of stressors. For example, it might be clear that water pollution is a problem in many freshwater systems but the many potential sources of pollutants might not be known. In these cases, it can be more productive to build a conceptual model starting with a stressor and known effects on components of interest. Potential sources can then be added as strategies and actions targeted at reducing the effect of stressors are developed.

### ***Mechanisms of Action***

Mechanisms of action are not included as elements in the taxonomy but they are useful for describing the relationship between pressures, stressors and ecosystem components or attributes. Stressors act on species, habitats and ecological processes via three primary mechanisms: 1) direct reduction of species

fecundity or survival, 2) habitat destruction, or 3) habitat degradation and fragmentation (Balmford et al 2008). For example, as illustrated in the diagram below, *residential and commercial development* is a source of *habitat conversion due to land use change* (stressor) that leads to the *destruction or fragmentation* (mechanism of action) of *terrestrial and freshwater ecosystems* (focal ecosystem components). Table A.3 summarizes the mechanisms of action and the primary stressors and sources acting via each mechanism.

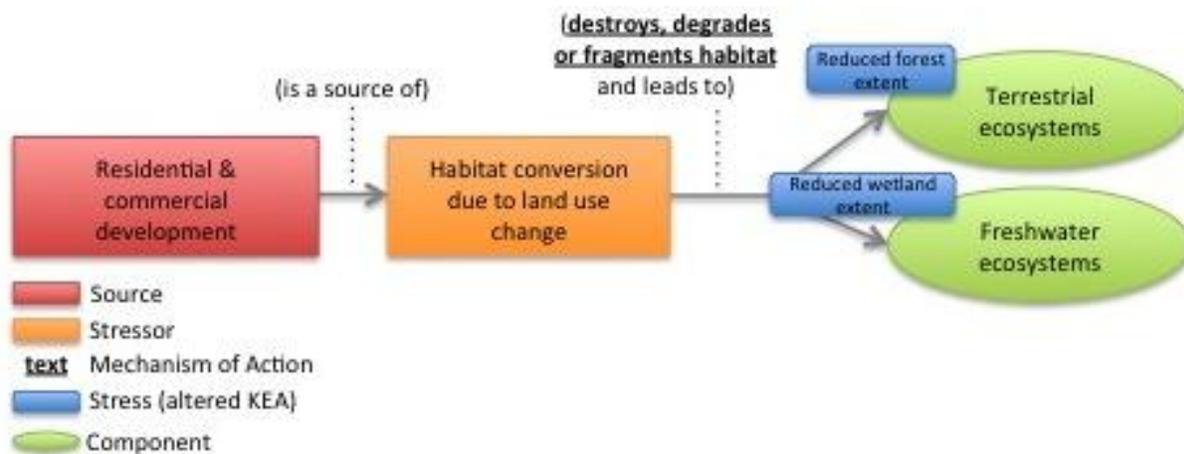


Reading from left to right, this pressure pathway diagram says that *development* is a source of *habitat conversion* (stressor) that negatively affects terrestrial and freshwater ecosystems (components) by destroying, degrading, or fragmenting habitat (mechanism of action).

### Stresses

“Stresses” refers to the ecological effects, or ultimate impacts, of a stressor or source-stressor pair on an ecosystem or species. We do not include stresses as a formal level of the pressure taxonomy but we address stresses directly because they can often be linked to specific stressors or source-stressor pairs. Common stresses are presented for each pressure class.

In Open Standards terms, stresses are equivalent to altered key ecological attributes (KEAs). KEAs are those aspects of an ecosystem component that if missing or altered would lead to the loss of the component or its ecological integrity. A stress therefore is most often related to the reduction or degradation of a KEA. For example, if *extent of forested habitat* is a KEA of *terrestrial ecosystems*, a stress might be represented as *reduced forest extent*. Similarly, if *water quality* is a KEA of *freshwater ecosystems*, a stress might be represented as *degraded (or impaired) water quality*.



Reading from left to right, this complete pressure pathway diagram says that *residential and commercial development* is a source of *habitat conversion due to land use change* (stressor) that leads to the destruction or fragmentation (mechanism of action) of *terrestrial and freshwater ecosystems* (focal ecosystem components). The primary ecological effects of this pressure pathway are *reduced forest extent* and *reduced wetland extent* (stresses).

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## **Appendices to 2013 Puget Sound Partnership Pressure Taxonomy**

- A.1 2013 Pressure Class Taxonomy Table
- A.2 2013 Stressor Taxonomy Table
- A.3 2009 “Threat” Taxonomy and 2009-2012 Revisions
- A.4 Pressure Ratings (2012 and 2009)
- A.5 2013 Pressure Class Descriptions and Pressure Network Diagrams

## A.1. 2013 Taxonomy of Pressures to Puget Sound Ecosystems (Pressure Classes)

The following table presents the highest of three levels in a classification system describing pressures to Puget Sound ecosystems. 29 pressure classes are grouped into ten pressure categories. This list of pressure classes is intended to be used with two companion lists of stressors (Table A.2) and mechanisms of action (Table A.3) to describe pathways of effect linking pressures to ecosystem components. Additional information about pressure classes and their relationship to other elements of the pressure taxonomy can be found at <https://sites.google.com/a/uw.edu/puget-sound-open-standards---temporary-share-site/documents/pressures-taxonomy>. This specific table is also available in a [Google spreadsheet](#).

**Table A.1 Taxonomy of Pressures to Ecological and Human Dimensions of the Puget Sound Ecosystem**

\* See Table A.2 for a companion taxonomy of Stressors

\*\* Stresses are provided as examples only. When developing pathways of effect linking sources to ecosystem components, relevant stresses should be described for the specific pressure-component relationship.

PSP Pressure Class	Definition	Related Stressors*	Common Stresses**
<b>1. Residential &amp; Commercial Development</b>			
<b>1.1 Residential &amp; Commercial Development</b>	Pressures associated with human settlements or other non-agricultural land uses with a substantial footprint, including residential, commercial, and industrial. This includes new and existing development. This does not include shoreline armoring, overwater structures, transportation and utility infrastructure, port and shipyard development, or runoff associated with any developed areas. (see related pressures)	<ul style="list-style-type: none"> <li>- habitat conversion – human land use change</li> <li>- pollution – air pollution</li> <li>- pollution – noise and light pollution</li> </ul>	<ul style="list-style-type: none"> <li>- reduced habitat extent</li> <li>- degraded habitat quality (connectivity, diversity, structure, etc)</li> <li>- reduced habitat corridor connectivity</li> <li>- altered hydrology</li> <li>- noise, light pollution</li> </ul>
<b>2. Agriculture &amp; Aquaculture</b>			

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
<b>2.1</b>	<b>Agriculture</b>	Pressures on ecosystem processes and human well being due to methods or location of farming. This includes non-timber crops planted for food, fiber, and other uses, nurseries and their physical impacts to the soil, vegetation, associated surface water resources (i.e. runoff or effluent from agricultural lands), and ditching in support of agriculture and hobby farms. This does not include pressures associated with livestock grazing or water withdrawals in support of agriculture (see related pressures)	<ul style="list-style-type: none"> <li>- habitat conversion – human land use change</li> <li>- hydromodification - ditching</li> <li>- pollution – toxics, nutrients, sediment, pathogens in water</li> <li>- soil compaction</li> </ul>	<ul style="list-style-type: none"> <li>- reduced habitat quality (connectivity, diversity, structure, etc)</li> <li>- reduced habitat extent</li> <li>- degraded water quality</li> <li>- altered hydrology</li> </ul>
<b>2.2</b>	<b>Livestock Grazing</b>	Pressures on ecosystem processes and human well being due to methods or location of livestock grazing activities. This includes domestic animals raised in one location and their physical impacts to the soil, vegetation, associated surface water resources (i.e. runoff or effluent from livestock grazing lands) and ditching. This does not include water withdrawals in support of livestock grazing (see related pressures)	<ul style="list-style-type: none"> <li>- habitat conversion – human land use change</li> <li>- hydromodification - ditching</li> <li>- pollution – air pollution</li> <li>- pollution – toxics, nutrients, sediment, pathogens in water</li> <li>- soil compaction</li> </ul>	<ul style="list-style-type: none"> <li>- reduced habitat quality (connectivity, diversity, structure, etc)</li> <li>- reduced habitat extent</li> <li>- degraded water quality</li> <li>- altered hydrology</li> </ul>
<b>2.3</b>	<b>Fin Fish Aquaculture</b>	Pressures put on ecosystem processes and human well being due to the location, intensification, or practice of fin fish aquaculture. This includes both hatchery and farm approaches and it includes pressures associated with permanent and temporary structures.	<ul style="list-style-type: none"> <li>- disease introduction</li> <li>- habitat conversion - human land use change</li> <li>- increased competition - due to increased native species?</li> <li>- increased predation - from native or introduced species?</li> <li>- pollution - toxics, nutrients, sediment, pathogens in water</li> </ul>	<ul style="list-style-type: none"> <li>- reduced genetic diversity</li> <li>- reduced abundance</li> <li>- reduced fecundity</li> <li>- reduced productivity</li> <li>- reduced habitat quality (structural, shading)</li> <li>- reduced water quality</li> </ul>
<b>2.4</b>	<b>Shellfish Aquaculture</b>	Pressures on ecosystem processes and human well being due to the location, intensification, or practice of shellfish aquaculture.	<ul style="list-style-type: none"> <li>- habitat conversion - human land-use change</li> <li>- increased predation - from native or introduced species?</li> <li>- pollution - nutrients, sediment, pathogens in water</li> </ul>	<ul style="list-style-type: none"> <li>- reduced abundance of native species</li> <li>- reduced health of native species</li> <li>- reduced genetic diversity of native populations</li> <li>- reduced habitat quality (structural, shading)</li> <li>- reduced water quality</li> </ul>

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
<b>2.5</b>	<b>Timber Harvesting</b>	Pressures from consumptive uses of biological resources including deliberate and unintentional harvesting effects of timber practices and harvesting. This includes pollution carried in runoff from managed forest lands. This does not include infrastructure associated with forest practices or water withdrawals associated with timber practices (see related pressures)	<ul style="list-style-type: none"> <li>- habitat conversion - human land use change</li> <li>- pollution - pesticide application</li> <li>- hydromodification - storage, delivery, transport</li> </ul>	<ul style="list-style-type: none"> <li>- reduced genetic diversity</li> <li>- reduced species abundance</li> <li>- disease</li> <li>- erosion</li> <li>- altered hydrology</li> <li>- altered sediment dynamics</li> </ul>
<b>3. Energy production &amp; Mining</b>				
<b>3.1</b>	<b>Energy Production &amp; Energy Emissions</b>	Pressures on ecosystem processes and human well being due to the production and use of biological and nonbiological sources for energy consumption. This includes industrial and residential (e.g. smoke from wood stoves) sources of airborne pollutants.	<ul style="list-style-type: none"> <li>- pollution - air pollution</li> <li>- pollution - atmospheric deposition</li> </ul>	<ul style="list-style-type: none"> <li>- reduced resilience</li> <li>- degraded water/aquatic habitat quality</li> <li>- reduced health</li> </ul>
<b>3.2</b>	<b>Mineral &amp; Gravel Mining</b>	Pressures associated with the extraction of nonbiological resources. This includes air and water pollution associated with mining and related activities. This does not include extraction of gravel from river or streambeds. (see related pressures)	<ul style="list-style-type: none"> <li>- habitat conversion - human land use change</li> <li>- pollution - toxics, nutrients, sediment, pathogens in water</li> </ul>	<ul style="list-style-type: none"> <li>- erosion/altered sediment dynamics</li> <li>- altered hydrology</li> <li>- degraded air/water quality</li> <li>- habitat loss</li> <li>- habitat degradation</li> </ul>
<b>4. Transportation &amp; Service Corridors</b>				
<b>4.1</b>	<b>Transportation &amp; Service Corridors</b>	Pressures associated with the quantity and location of transportation and service networks, including boats, cars, trains & pipelines, and roads associated with timber harvest. This includes air pollution from vehicles and non-recreational vessels as well as direct discharge and damage from wakes and anchors from non-recreational vessels, including commercial transport and tourist ships in freshwater and marine waterways. This does not include runoff or accidental spills associated with transportation networks, derelict vessels, or pressures associated with recreational vessels. (see related pressures)	<ul style="list-style-type: none"> <li>- habitat conversion - human land-use change</li> <li>- pollution - toxics, nutrients, sediment, pathogens in water</li> <li>- species disturbance</li> <li>- pollution – air pollution</li> </ul>	<ul style="list-style-type: none"> <li>- reduced habitat extent</li> <li>- degraded habitat quality (reduced connectivity, species diversity, etc)</li> <li>- degraded air quality</li> <li>- degraded water quality</li> <li>- reduced human health (accidents, air/water quality, etc)</li> </ul>

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
<b>4.2</b>	<b>Dredging &amp; Dredged Material</b>	Pressures associated with the dredging and disposal of material from river and harbor systems.	<ul style="list-style-type: none"> <li>- habitat conversion - human land-use change</li> <li>- pollution - release of legacy toxics</li> <li>- pollution – air pollution</li> </ul>	<ul style="list-style-type: none"> <li>- loss of habitat</li> <li>- degraded habitat quality</li> <li>- degraded water quality</li> <li>- increased turbidity</li> <li>- altered sediment dynamics</li> </ul>
<b>5. Biological Resource Use</b>				
<b>5.1</b>	<b>Animal Harvesting (Aquatic)</b>	Pressures from consumptive uses of aquatic biological resources including deliberate and unintentional harvesting effects on wild and cultivated species. This includes both recreational and commercial harvest. This does not include derelict fishing gear or vessels. (see related pressures)	<ul style="list-style-type: none"> <li>- bycatch</li> <li>- harvest</li> </ul>	<ul style="list-style-type: none"> <li>- reduced genetic diversity</li> <li>- reduced abundance</li> <li>- reduced fecundity</li> <li>- reduced productivity</li> </ul>
<b>5.2</b>	<b>Animal Harvesting (Terrestrial)</b>	Pressures from consumptive uses of terrestrial biological resources including deliberate and unintentional harvesting effects on wild and managed species. This includes both recreational and commercial harvest.	<ul style="list-style-type: none"> <li>- harvest</li> </ul>	<ul style="list-style-type: none"> <li>- reduced genetic diversity</li> <li>- reduced abundance</li> <li>- reduced fecundity</li> <li>- reduced productivity</li> </ul>
<b>6. Human Intrusions &amp; Disturbance</b>				
<b>6.1</b>	<b>Recreational Activities</b>	Pressures from human activities that alter, destroy, and disturb habitats and species associated with non-consumptive uses of biological resources. This includes recreational vessels, off-road vehicles, and associated air and water pollution, but not NPDES-regulated hull-cleaning (see Pollution pressures). This does not include impacts from commercial whale watching vessels (see <i>Transportation &amp; Service Corridors</i> ), commercial recreational activities, non-recreational boat discharge, marinas or transportation networks associated with recreational activities or derelict gear and vessels (see related pressures).	<ul style="list-style-type: none"> <li>- habitat degradation</li> <li>- pollution - toxics, nutrients, sediment, pathogens in water</li> <li>- species disturbance</li> <li>- pollution – air pollution</li> </ul>	<ul style="list-style-type: none"> <li>- erosion</li> <li>- degraded species condition</li> <li>- degraded air quality</li> <li>- degraded water quality</li> </ul>

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
<b>6.2</b>	<b>Military Exercises</b>	Pressures associated with military exercises that alter, destroy, and disturb habitats and species. This does not include development associated with permanent military bases (see related pressures).	<ul style="list-style-type: none"> <li>- defoliation</li> <li>- habitat conversion - human land-use change</li> <li>- habitat degradation</li> <li>- pollution - munitions testing</li> <li>- pollution - underwater bombs &amp; testing</li> </ul>	<ul style="list-style-type: none"> <li>- loss of habitat</li> <li>- degraded vegetation condition (defoliation)</li> <li>- impaired animal condition (sonar, health)</li> <li>- reduced species abundance</li> </ul>
<b>6.3</b>	<b>Derelict fishing gear</b>	Pressures associated with presence of derelict gear and vessels, both commercial and recreational, including destruction or degradation of habitats and disturbance of species. This does not include spills associated with derelict vessels.	<ul style="list-style-type: none"> <li>- derelict fishing gear and vessels</li> </ul>	<ul style="list-style-type: none"> <li>- altered marine habitat structure</li> <li>- reduced abundance (trapped/suffocated by derelict gear)</li> </ul>
<b>7. Natural System Modifications</b>				
<b>7.1</b>	<b>Dams</b>	Pressures from actions that convert or degrade habitat or alter hydrology via putting in dams to manage how and when water flows through a system, often to improve human welfare.	<ul style="list-style-type: none"> <li>- fish passage barriers</li> <li>- habitat destruction - altered hydrology</li> <li>- hydromodification - flow regulation</li> <li>- hydromodification - structural barriers to water, sediment, debris flow</li> </ul>	<ul style="list-style-type: none"> <li>- species passage limitations</li> <li>- altered water availability</li> <li>- altered sediment dynamics</li> <li>- altered hydrological dynamics</li> <li>- loss of terrestrial/freshwater habitat upstream</li> </ul>
<b>7.2</b>	<b>Culverts</b>	Pressures from actions that convert or degrade habitat or alter hydrology via putting in culverts to manage the flow and passage of water, sediment, and species.	<ul style="list-style-type: none"> <li>- fish passage barriers</li> <li>- hydromodification - structural barriers to water, sediment, debris flow</li> </ul>	<ul style="list-style-type: none"> <li>- species passage limitations</li> <li>- altered hydrological dynamics</li> <li>- altered sediment dynamics</li> </ul>
<b>7.3</b>	<b>Freshwater Levees &amp; Floodgates</b>	Pressures from actions that convert or degrade habitat or alter hydrology via establishing levees & floodgates along freshwater systems to manage the hydrologic flow in a system, often to improve human welfare.	<ul style="list-style-type: none"> <li>- fish passage barriers</li> <li>- habitat destruction - altered hydrology</li> <li>- hydromodification - structural barriers to water, sediment, debris flow</li> </ul>	<ul style="list-style-type: none"> <li>- altered hydrological processes</li> <li>- altered sediment dynamics</li> <li>- altered nutrient/organic dynamics</li> <li>- flood intensification</li> <li>- species passage limitations</li> <li>- reduced habitat connectivity</li> </ul>

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
7.4	<b>Marine Water Levees &amp; Tidegates</b>	Pressures from actions that convert or degrade habitat or alter hydrology via establishing levees & tidegates along marine water systems to manage or exclude marine water into the freshwater system, often to improve human welfare.	<ul style="list-style-type: none"> <li>- fish passage barriers</li> <li>- habitat destruction - altered hydrology</li> <li>- hydromodification - structural barriers to water, sediment, debris flow</li> </ul>	<ul style="list-style-type: none"> <li>- altered hydrological processes</li> <li>- altered sediment dynamics</li> <li>- altered nutrient/organic dynamics</li> <li>- flood intensification</li> <li>- species passage limitations</li> <li>- reduced habitat connectivity</li> </ul>
7.5	<b>Freshwater Shoreline Infrastructure</b>	Pressures from the armoring of freshwater shorelines and overwater structures that alter, destroy, and disturb habitats and species via a nonconsumptive use, including industrial, commercial, and recreational marinas, ports and shipyards. This includes air pollution from shoreline facilities. This does not include runoff from impervious surfaces or other water pollution (see related pressures). If useful for development of pathways of effect in a given region, this pressure class could be divided into two subclasses addressing infrastructure associated with residential development (7.5.1) and infrastructure associated with non-residential development (7.5.2).	<ul style="list-style-type: none"> <li>- habitat conversion - human land-use change</li> <li>- increased predation - due to OWS and shading</li> <li>- overwater structures</li> <li>- shoreline armoring</li> <li>- pollution - air pollution</li> </ul>	<ul style="list-style-type: none"> <li>- altered sediment processes/drift cell processes</li> <li>- degraded habitat (due to shading)</li> <li>- reduced abundance (due to increased predation (more predators in shady habitat))</li> </ul>
7.6	<b>Marine Shoreline Infrastructure</b>	Pressures from armoring of marine shorelines and overwater structures that alter, destroy, and disturb habitats and species via a nonconsumptive use, including industrial, commercial and recreational marinas, ports and shipyards. This includes air pollution from shoreline facilities. This does not include runoff from impervious surfaces or other water pollution (see related pressures). If useful for development of pathways of effect in a given region, this pressure class could be divided into two subclasses addressing infrastructure associated with residential development (7.6.1) and infrastructure associated with non-residential development (7.6.2).	<ul style="list-style-type: none"> <li>- habitat conversion - human land-use change</li> <li>- increased predation - due to OWS and shading</li> <li>- overwater structures</li> <li>- shoreline armoring</li> <li>- pollution – air pollution</li> </ul>	<ul style="list-style-type: none"> <li>- altered sediment processes/drift cell processes</li> <li>- degraded habitat (due to shading)</li> <li>- reduced abundance (due to increased predation (more predators in shady habitat))</li> </ul>
<b>8. Invasive &amp; Other Problematic Species &amp; Genes</b>				

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
<b>8.1</b>	<b>Invasive Species (Aquatic, Terrestrial)</b>	Pressures associated with the introduction and distribution of non-native species or genes that are capable of aggressively establishing or causing environmental damage.	- increased competition - due to increased non-native species - introduced genetic material	- competition - genetic disruption - predation - habitat degradation
<b>9. Pollution</b>				
<b>9.1</b>	<b>Runoff from Built Environment</b>	Pressures from the introduction of exotic or excess material into hydrologic system due to surface water loading and runoff from the built environment. The "built environment" includes commercial, residential, and industrial lands and transportation facilities and corridors. This includes hull-cleaning and other pollution from marina infrastructure and land-based boat maintenance practices (i.e. NPDES regulated activities that occur in marinas and shipyards). This does not include loading from septic systems (OSS), combined sewer overflows (CSOs), or runoff from other activities (e.g., agriculture, timber harvest). (see related pressures)	- hydromodification - altered volume and timing of runoff - pollution - toxics, nutrients, sediment, pathogens in water	- toxics - degraded water quality (temperature, turbidity) - altered hydrological dynamics - altered nutrient levels
<b>9.2</b>	<b>Industrial, Domestic &amp; Municipal Wastewater</b>	Pressures associated with discharge from municipal and industrial WWTPs into hydrologic systems. This includes water-borne sewage that includes nutrients, pathogens, toxic chemicals, and sediments. This does not include discharge from municipal combined sewer overflows (CSOs), onsite sewage systems (OSS), wastewater discharged from recreational and other vessels, or biosolids applied in terrestrial environments. (see related pressures)	- pollution - toxics, nutrients, sediment, pathogens in water	- toxics - degraded water quality
<b>9.3</b>	<b>Onsite Sewage Systems (OSS)</b>	Pressures associated with discharges from Onsite Sewage Systems (OSS). This includes sewage and leachates (nutrients, toxic chemicals and/or sediment) from residences not connected to a municipal system (septics, small private systems, and everything with a drain field).	- pollution - toxics, nutrients, sediment, pathogens in water	- degraded water quality

PSP Pressure Class		Definition	Related Stressors*	Common Stresses**
9.4	<b>Combined Sewer Overflows) CSOs</b>	Pressures associated with discharge from municipal Combined Sewer Overflows (CSOs)	- pollution - toxics, nutrients, sediment, pathogens in water	- toxics - degraded water quality
9.5	<b>Toxics &amp; Legacy Contaminants</b>	Pressures associated with the existence of contaminated soils and lands, including sources and pathways of toxic loading from brownfields and superfund sites. This includes legacy contaminants that are already located in hydrologic systems, that reach hydrologic systems via groundwater, or that directly harm terrestrial systems.	- toxics in environment	- toxics - degraded water quality
9.6	<b>Oil &amp; Hazardous Spills</b>	Pressures associated with the accidental, episodic, or potentially catastrophic spill of oil and hazardous waste in aquatic and terrestrial environments. This does not include chronic or other frequent, smaller pollution events related to normal operations of vehicles, vessels, etc. (see related pressures)	- toxic spills	- species kill - habitat degradation or destruction - impaired species condition - impaired habitat condition
<b>10. Water Withdrawals &amp; Diversions</b>				
10.1	<b>Water Withdrawals &amp; Diversions</b>	Pressures associated with modification, extraction, or diversion of water supplies, including water withdrawals and diversions associated with agriculture, forestry practices and exempt wells. This includes changing water flow patterns, such as instream flows, from their natural range of variation either deliberately as a result of water supply or flood management operations.	- hydromodification - water diversion - hydromodification - water extraction	- reduced volume - groundwater - reduced volume - surface flow - degradation/loss of habitat

## A.2. 2013 Taxonomy of Stressors to Puget Sound Ecosystem Components

Sources of stress, as described in the 2013 Pressure Taxonomy, are not usually the most proximal actors on ecosystem components. Most sources act on the ecosystem via one or more stressors. For example, the pressure source *Residential & Commercial Development* acts directly on ecosystem components via stressors such as habitat conversion and pollution (air, noise, and light), as well as indirectly via increasing the need for other pressures, or sources of stress, including *Transportation & Service Corridors* and *Runoff from the Built Environment*. The Taxonomy of Stressors presented here represents the second level in the 2013 Pressure Taxonomy and describes the most proximal actors on ecosystem components. The table also includes the most common mechanisms by which stressors act on Puget Sound ecosystems.

**Table A.2 Taxonomy of Stressors to Puget Sound Ecosystem**

\* 1 = direct reduction of survival or fecundity; 2 = habitat destruction; 3 = habitat degradation or fragmentation

\*\* In these cases, the PSP Pressure Taxonomy has defined a pressure at the level of stressor, rather than source. In all other cases, stressors are delivered by one or more sources.

Stressor	Mechanism of Action*	Related Pressures (primary sources of stressor)
a. Bycatch (unintended harvest)	1	5.1 Animal Harvesting (Aquatic)
b. Derelict fishing gear and vessels	1	6.5 Derelict Fishing Gear
c. Disease introduction	1	2.3 Fin Fish Aquaculture
d. Fish passage barriers	1	7.1 Dams 7.2 Culverts 7.3 Freshwater Levees & Floodgates 7.4 Marine Water Levees & Tidegates
e. Habitat conversion due to human land-use change	2	1.1 Residential & Commercial Development 2.1 Agriculture 2.2 Livestock Grazing 2.3 Fin Fish Aquaculture 2.4 Shellfish Aquaculture 2.5 Timber Harvesting 3.2 Mineral & Gravel Mining 4.1 Transportation & Service Corridors 4.2 Dredging & Dredged Material 6.2 Military Exercises 7.5 Freshwater Shoreline Infrastructure 7.6 Marine Shoreline Infrastructure
f. Habitat degradation	3	6.1 Recreational Activities 6.2 Military Exercises
g. Defoliation	3	6.2 Military Exercises

h. Habitat destruction due to altered hydrology	2	7.1 Dams 7.3 Freshwater Levees & Floodgates 7.4 Marine Water Levees & Tidegates
i. Harvest	1	5.1 Animal Harvesting (Aquatic) 5.2 Animal Harvesting (Terrestrial)
j. Hydromodification - altered volume and timing of runoff	3	9.1 Runoff from Built Environment
k. Hydromodification - ditching	3	2.1 Agriculture 2.2 Livestock Grazing
l. Hydromodification - flow regulation	3	7.1 Dams
m. Hydromodification - structural barriers to water, sediment, debris flow	3	7.1 Dams 7.2 Culverts 7.3 Freshwater Levees & Floodgates 7.4 Marine Water Levees & Tidegates
n. Hydromodification - water diversion	3	10.1 Water Withdrawals & Diversions
o. Hydromodification - water extraction	3	10.1 Water Withdrawals & Diversions
p. Increased competition - due to increased native species	1	2.3 Fin Fish Aquaculture
q. Increased competition - due to increased non-native species	1	8.1 Invasive Species (Aquatic, Terrestrial)
r. Increased predation - due to OWS and shading	1	7.5 Freshwater Shoreline Infrastructure 7.6 Marine Shoreline Infrastructure
s. Increased predation - due to increased native or introduced species	1	2.3 Fin Fish Aquaculture 2.4 Shellfish Aquaculture
t. Introduced genetic material	1	8.1 Invasive Species (Aquatic, Terrestrial)
u. Overwater structures	3	7.5 Freshwater Shoreline Infrastructure 7.6 Marine Shoreline Infrastructure
v. Pollution - air pollution	3	1.1 Residential & Commercial Development 3.1 Energy Production & Energy Emissions 4.1 Transportation & Service Corridors 6.1 Recreational Activities
w. Pollution - atmospheric deposition	1	3.1 Energy Production & Energy Emissions
x. Pollution - pesticide application	1	2.5 Timber Harvesting
y. Pollution - munitions testing	1	6.2 Military Exercises
z. Pollution - release of legacy toxics	1 3	4.2 Dredging & Dredged Material

aa. Pollution - toxics, nutrients, sediment, pathogens in water	1 3	2.1 Agriculture 2.2 Livestock Grazing 2.3 Fin Fish Aquaculture 2.4 Shellfish Aquaculture 4.1 Transportation & Service Corridors 6.1 Recreational Activities 9.1 Runoff from Built Environment 9.2 Industrial, Domestic & Municipal Wastewater 9.3 OSS 9.4 CSO
bb. Pollution - underwater bombs & testing	1	6.2 Military Exercises
cc. Shoreline hardening	3	7.5 Freshwater Shoreline Infrastructure 7.6 Marine Shoreline Infrastructure
dd. Soil compaction	3	2.1 Agriculture 2.2 Livestock Grazing
ee. Species disturbance	1	6.1 Recreational Activities
ff. Toxic spills	1 3	9.6 Oil & Hazardous Spills
gg. Toxics in environment	1	9.5 Toxics & Legacy Contaminants

### A.3. 2009 “Threat” Taxonomy and Revisions

This section provides a summary of the past three years of revisions to the first Soundwide “threat” taxonomy published by the Puget Sound Partnership in 2009 (S.O.S. 2009).

Revisions to the overall structure of the taxonomy include the following:

- The taxonomy has been revised to use the term “Pressures” rather than “Threats” to describe sources of stress and stressors to Puget Sound ecosystems and species
- The original 26 pressures have been revised to encompass 29 pressure classes grouped into ten pressure categories
- Pressure definitions have been expanded to include descriptions of sources, stressors, examples of ecosystem stresses, and related pressures and drivers
- Pressure network diagrams have been developed to illustrate relationships between the 29 pressure classes, including illustrations of relationships between sources, stressors, stresses, related pressures, and drivers

Revisions to the 26 original “threat” classes published in 2009 are summarized in Table A.4.

**Table A.3 2009 Threat Taxonomy and 2013 Revisions**

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Agriculture & Livestock Grazing	This threat class includes: <ul style="list-style-type: none"> <li>• non-timber crops planted for food, fiber, or other uses</li> <li>• domestic animals raised in one location and their physical impacts to soils, vegetation, and associated surface water resources (effluent)</li> <li>• nurseries</li> <li>• ditching in support of agriculture</li> <li>• hobby farms and agricultural zoned lands</li> </ul>	split into two pressure classes: <i>Agriculture, Livestock Grazing</i>

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Air Pollution & Atmospheric Deposition	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>atmospheric pollutants from airborne point and non-point sources, both domestic and international</li> <li>acid rain</li> <li>smog from vehicle emissions and industrial sources</li> <li>nitrogen deposition</li> <li>radioactive fallout</li> <li>wind dispersion of pollutants or sediments</li> <li>smoke from forest fires or wood stoves</li> <li>carbon dioxide emissions leading to ocean acidification</li> </ul>	no longer included as a unique pressure and is now covered as a stressor associated with various sources of air pollution and atmospheric deposition: <i>Energy Production &amp; Emissions, Mineral &amp; Gravel Mining, Recreational Activities, Shoreline Infrastructure (Freshwater and Marine), Transportation &amp; Service Corridors</i>
Aquaculture	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>aquatic animals raised in one location (e.g., net pens)</li> <li>hatchery salmon allowed to roam in the wild (genetics, nutrients, sea lice)</li> <li>hatchery operations (effluent, antibiotics, etc.)</li> <li>shrimp or fin fish aquaculture</li> <li>fish ponds on farms</li> <li>seeded shellfish beds</li> <li>artificial algal beds</li> </ul>	split into two pressure classes: <i>Fin Fish Aquaculture, Shellfish Aquaculture</i>
Climate Change	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>threats from long-term climatic changes, which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or can cause the extinction or extirpation of a vulnerable species or obliterate a habitat type</li> <li>climatic events increasing in frequency or intensity outside their natural range of variation due to human causes; related stressors include salinity change, sea level rise, snowpack change, ocean acidification, temperature change, amplification of invasive species, increased flooding</li> </ul>	no longer included as a unique pressure

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Dams, Levees & Tidegates	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>impeding or rerouting surface or subsurface hydrology through the placement, operation, or maintenance of a structure, either deliberately or as a result of other activities</li> <li>dams, levees, revetments, tidegates and other freshwater shoreline armoring</li> </ul> <p>This threat class <u>does not</u> include water withdrawals &amp; diversions, marine shoreline armoring, or overwater structures.</p>	split into four separate pressure classes within a single pressure category, Natural System Modifications: <i>Dams, Culvert,; Freshwater Levees &amp; Floodgates, Marine Water Levees &amp; Tidegates</i>
Derelict Gear & Vessels	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>abandoned and lost gear that continues to catch fish and alters habitat</li> </ul> <p>This threat class <u>does not</u> include marine habitat degradation that results from harvest of marine resources, which is accounted for within the direct-threat class, 'unsustainable fishing/harvesting'</p>	definition retained but renamed <i>Derelict Fishing Gear</i>
Dredging & Dredged Material Disposal	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>gravel extraction and disposal from freshwater habitats</li> <li>dredging in nearshore/marine environments in support of shipping lanes and marine transportation</li> </ul>	no change
Invasive Species and Other Problematic Species - Terrestrial	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance</li> </ul>	combined with other two 2009 invasive species threats into a single pressure class: <i>Invasive Species (Aquatic &amp; Terrestrial)</i>
Invasive Species and Other Problematic Species -Freshwater	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance</li> </ul>	combined with other two 2009 invasive species threats into a single pressure class: <i>Invasive Species (Aquatic &amp; Terrestrial)</i>

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Invasive Species and Other Problematic Species - Marine	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance</li> <li>• ballast water</li> </ul>	combined with other two 2009 invasive species threats into a single pressure class: <i>Invasive Species (Aquatic &amp; Terrestrial)</i>
Large Scale Timber Harvest	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• industrial or large-scale commercial harvesting of trees and other woody vegetation for timber, fiber or fuel</li> <li>• associated forest roads, effluent and runoff, including pesticides</li> </ul>	revised and renamed pressure class, <i>Timber Harvesting</i> ; definition revised to include smaller scale timber producers; transportation infrastructure associated with forestry removed from this pressure class and moved to <i>Transportation &amp; Service Corridors</i> ; culverts removed from this pressure class to create a unique pressure: <i>Culverts</i>
Military Exercises	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• Land-based maneuvers and training with tanks and other military vehicles</li> <li>• Defoliation</li> <li>• Munitions testing</li> <li>• Underwater detonations and submarine maneuvers</li> </ul> <p>This threat class <u>does not</u> include the impervious surfaces and development associated with permanent military bases, these are captured within the residential, commercial, port and shipyard threat class.</p>	no change
Mineral / Gravel Mining	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• Exploring for, developing, and producing minerals and rocks (quarries, gold, etc)</li> </ul> <p>This threat class <u>does not</u> include extraction of gravel from river or stream beds.</p>	definition expanded to include associated air pollution and water pollution

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Oil & Hazardous Spills	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>accidents on land and water that result in water-borne pollutants or toxics in natural systems</li> </ul> <p>This threat class <u>does not</u> include pollutants from stormwater, wastewater treatment plants, CSOs, or other contaminant sources.</p>	definition revised to clarify focus on episodic, not chronic events
Onsite Sewage Systems	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>sewage and leachates from residences not connected to a municipal system (septics, small private systems, and everything with a drain field)</li> <li>nutrients, toxic chemicals and/or sediment from these onsite systems</li> </ul>	no change
Point Source Pollution	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>industrial, military and commercial point source pollution</li> <li>cruise ships and other commercial &amp; industrial boat discharge</li> <li>legacy toxic sites in the marine and near-shore environments</li> </ul> <p>This threat class <u>does not</u> include surface water runoff, wastewater discharge, or air emissions.</p>	no longer included as a unique pressure; now included within <i>Industrial, Domestic &amp; Municipal Wastewater</i>
Recreational Activities	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>nature-based recreational activities such as hunting, recreational fishing, beach access, hiking, cross-country skiing, mountain bicycling, rock climbing, bird watching, camping and swimming</li> </ul> <p>This threat class <u>does not</u> include commercial whale watching, commercial recreational activities or recreation boat discharge.</p>	definition revised to include associated air emissions and water pollution
Recreational Marinas	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>marinas, jetties, docks, piers and other compact footprint structures</li> </ul> <p>This threat class <u>does not</u> include hull-cleaning and other NPDES regulated activities that occur in marinas.</p>	no longer a unique pressure; pressures associated with marina facilities and infrastructure are included within <i>Marine Shoreline Infrastructure</i> and <i>Freshwater Shoreline Infrastructure</i>

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Residential, Industrial, Commercial, Port & Shipyard Development	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• developed portions of the environment, or other non-agricultural land uses with a substantial footprint, such as those associated with residential, commercial, and industrial land uses</li> <li>• landfills, ports, military shipyards, and log rafting (only habitat destruction)</li> </ul> <p>This threat category <u>does not</u> include transportation infrastructure or run-off generated from developed portions of the environment.</p>	renamed <i>Residential &amp; Commercial Development</i> ; port & shipyard development moved to <i>Marine Shoreline Infrastructure</i> and <i>Freshwater Shoreline Infrastructure</i>
Roads, Transportation & Utility Infrastructure	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• surface transport on roadways and dedicated tracks</li> <li>• long narrow transport corridors and the vehicles that use them</li> <li>• transport of energy and resources</li> <li>• effects of construction on habitat, including ongoing fragmentation</li> </ul> <p>This threat class <u>does not</u> include: forest logging roads, ancillary roads in urban areas, shoreline armoring, runoff, effluent, or air emissions.</p>	renamed <i>Transportation &amp; Service Corridors</i> ; revised to include air emissions, vessel traffic and non-recreational discharges, and forest roads
Shoreline Armoring	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• bulkheads, riprap, and other linear shoreline modifications associated with roads, railroads, residential development</li> <li>• near-shore and freshwater shoreline armoring which supports transportation and utility ROWs</li> </ul> <p>This threat class <u>does not</u> include: flood control shoreline armoring (levees and revetments). The footprints associated with transportation and utility ROWs are included within the Transportation and Utility Infrastructure threat class; this threat class includes only the shoreline armoring, which often supports those ROWs.</p>	split into two unique pressures: <i>Marine Shoreline Infrastructure</i> and <i>Freshwater Shoreline Infrastructure</i> ; definition revised to include facilities and infrastructure associated with port, shipyard, and marina development; definition revised to include air pollution

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Surface Water Loading & Runoff from the Built Environment	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• activities regulated by NPDES</li> <li>• stormwater water runoff, including toxics, nutrients, pathogens, etc</li> <li>• runoff from roads, rail corridors, and transportation infrastructure</li> <li>• non-point source pollution from marina infrastructure + land-based recreational boat maintenance practices</li> <li>• best management and containment practices for residential, commercial, and industrial land uses</li> </ul> <p>This threat class <u>does not</u> include loading from septic systems, agriculture or forestry practices.</p>	definition retained but renamed <i>Runoff from the Built Environment</i>
Unsustainable Fishing / Harvesting	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• overharvesting and bycatch of fish and shellfish from both legal and illegal practices</li> <li>• marine/freshwater habitat destruction from fishing practices</li> </ul> <p>This threat class <u>does not</u> include derelict gear or recreational fishing.</p>	removed qualifier "unsustainable" and split into two unique pressures: <i>Animal Harvest (Aquatic)</i> , <i>Animal Harvest (Terrestrial)</i>
Vessel Traffic & Interaction	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• commercial transport and tourist ships on and in freshwater and marine waterways</li> <li>• shipping lanes</li> <li>• commercial whale-watching vessels</li> <li>• wakes from cargo ships</li> <li>• anchor damage from dive boats</li> </ul> <p>This threat class <u>does not</u> include recreational boating in freshwater and marine waterways.</p>	no longer a unique pressure; covered within <i>Transportation &amp; Service Corridors</i>

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Wastewater Treatment Plant Discharge & CSOs	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• water-borne sewage from housing and urban areas that include nutrients, toxic chemicals , pathogens, and/or sediments</li> <li>• Municipal wastewater treatment facilities</li> <li>• Combined sewer overflows (CSOs)</li> </ul> <p>This threat class <u>does not</u> include bio solids applied in terrestrial environments.</p>	<p>renamed <i>Industrial, Domestic &amp; Municipal Wastewater</i> and revised as follows: point source pollution from industries is included; CSOs were removed to create a unique pressure class, <i>Combined Sewer Overflows</i></p>
Water Withdrawals & Diversions	<p>This threat class includes:</p> <ul style="list-style-type: none"> <li>• extraction and diversion of water in support of residential, industrial, commercial, and other rural and municipal uses</li> <li>• changing water flow patterns, such as instream flows, from their natural range of variation either deliberately as a result of water supply or flood management operations</li> </ul>	<p>definition revised to include withdrawals associated with agriculture and forestry</p>

2009 Direct Threat Class	2009 Puget Sound Definitions	Summary of Revisions (2009-2013)
Governmental Arrangements	<p>This threat class is more precisely an ‘indirect threat or driver’ and includes formal, legally mandated, informal or voluntary relationships between local, state, and federal agencies and entities; interactions between local, state, and federal agencies and entities; results and outcomes from actions taken by individual agencies and entities over time.</p> <p>This indirect class of threats <u>does not</u> include NGOs, private property owners, and other non-governmental groups.</p> <p>Sub-categories of this indirect threat class include:</p> <ul style="list-style-type: none"> <li>• Cross-cutting and ecosystem scale actions: some scientific endeavors such as some monitoring efforts and modeling, some broad planning exercises and documents such as HCPs, some permits aimed at addressing multiple threats, integration efforts such as harvest, hatching and restoration in the regional salmon recovery plan.</li> <li>• Performance system that addresses a central part of the Partnership’s mission</li> <li>• Funding issues that are not specific to a specific threat</li> <li>• Education and outreach efforts not targeted to a specific threat</li> </ul>	Not included as a pressure class in new taxonomy

## A.4. Puget Soundwide Pressure Rating

The first Soundwide rating and ranking of pressures to Puget Sound ecosystems was completed by PSP in 2009. A small number of pressures were revised and re-rated in 2012 in support of strategy and near-term action prioritization as part of the 2012 Action Agenda update. Table A.4.1 summarizes available ratings as of July 2012 for the pressure classes as defined in the 2013 Pressure Taxonomy. For a description of how the pressures were rated and a discussion of how the ratings were used to inform strategy and action prioritization see the 2012 *Action Agenda Update* (Action Agenda 2012), the 2009 *State of the Sound* report (S.O.S. 2009), and *Identification, Definition and Rating of Threats to the Recovery of Puget Sound, A Technical Memorandum to the State of the Sound 2009* (Neuman, et al 2009).

**Table A.4.1 2012 Soundwide Pressure Rating**

\* ( ) denotes pressure ratings that are not based on the current definition as of July 2012. For the original 2009 Soundwide ratings see Table A.4.2

PSP Pressure Categories and Classes		available rating*	dates of rating	Notes
1.1	Residential & Commercial Development	(Very High)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined; port and shipyard development were included in the original 2009 rating but are no longer included in this definition; air emissions associated with development were not included in 2009.
2.1	Agriculture	Low	2012, 2009	The available rating from June 2012 addresses this pressure as currently defined.
2.2	Livestock Grazing	Low	2012, 2009	The available rating from June 2012 addresses this pressure as currently defined.
2.3	Fin Fish Aquaculture	(Low)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined. The 2009 rating addresses a single related pressure, "Aquaculture", and does not consider fin fish and shellfish aquaculture separately.
2.4	Shellfish Aquaculture	(Low)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined. The 2009 rating addresses a single related pressure, "Aquaculture", and does not consider fin fish and shellfish aquaculture separately.

PSP Pressure Categories and Classes		available rating*	dates of rating	Notes
2.5	Timber Harvesting	(Low)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined. The rating from 2009 only addresses large scale timber harvest.
3.1	Energy Production & Energy Emissions	-	-	This pressure as currently defined has not yet been rated.
3.2	Mineral & Gravel Mining	(Low)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined; air emissions are excluded.
4.1	Transportation & Service Corridors	(High)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined; air emissions are excluded.
4.2	Dredging & Dredged Material	Low	2009	The available rating from 2009 addresses this pressure as currently defined.
5.1	Animal Harvesting (Aquatic)	(High)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined. The 2009 rating is for a single related pressure, "Unsustainable Fishing".
5.2	Animal Harvesting (Terrestrial)	-	-	This pressure as currently defined has not yet been rated.
6.1	Recreational Activities	(Medium)	2009	The available rating from 2009 <u>does not</u> address this pressure as currently defined; air emissions are not included
6.2	Military Exercises	Low	2009	The available rating from 2009 addresses this pressure as currently defined.
6.5	Derelict Fishing Gear	Low	2009	The available rating from 2009 addresses this pressure as currently defined.
7.1	Dams	-	-	There is not a rating available for this pressure as currently defined. In 2009, a single related pressure including dams, levees, tidegates, and culverts was rated.

PSP Pressure Categories and Classes		available rating*	dates of rating	Notes
7.2	Culverts	-	-	There is not a rating available for this pressure as currently defined. In 2009, a single related pressure including dams, levees, tidegates, and culverts was rated.
7.3	Freshwater Levees & Floodgates	-	-	There is not a rating available for this pressure as currently defined. In 2009, a single related pressure including dams, levees, tidegates, and culverts was rated.
7.4	Marine Water Levees & Tidegates	-	-	There is not a rating available for this pressure as currently defined. In 2009, a single related pressure including dams, levees, tidegates, and culverts was rated.
7.5	Freshwater Shoreline Infrastructure	-	-	There is not a rating available for this pressure as currently defined. In 2009, related pressures "Shoreline Armoring", "Recreational Marinas" and "Residential, Commercial, Port & Shipyard Development" were all rated independently.
7.6	Marine Shoreline Infrastructure	-	-	There is not a rating available for this pressure as currently defined. In 2009, related pressures "Shoreline Armoring", "Recreational Marinas" and "Residential, Commercial, Port & Shipyard Development" were all rated independently.
8.1	Invasive Species (Aquatic, Terrestrial)	(High, Medium)	2009	There is not a rating available for this pressure as currently defined. The available rating from 2009 for invasive species rated three separate pressures associated with marine, freshwater and terrestrial invasive species.
9.1	Runoff from Built Environment	High	-	The available rating from 2009 addresses this pressure as currently defined
9.2	Industrial, Domestic & Municipal Wastewater	Low	2012, 2009	The available rating from June 2012 addresses this pressure as currently defined
9.3	Onsite Sewage Systems (OSS)	Medium	2009	The available rating from 2009 addresses this pressure as currently defined
9.4	Combined Sewer Overflows	Low	2012	The available rating from June 2012 addresses this pressure as currently defined

PSP Pressure Categories and Classes		available rating*	dates of rating	Notes
	(CSOs)			
9.5	Toxics & Legacy Contaminants	Low	2012	The available rating from June 2012 addresses this pressure as currently defined
9.6	Oil & Hazardous Spills	Low	2012, 2009	The available rating from June 2012 addresses this pressure as currently defined
10.1	Water Withdrawals & Diversions	(Medium)	2009	The available rating from 2009 <u>does not</u> address withdrawals and diversions for all uses (i.e. agriculture and forestry)

In 2009, threats to the Puget Sound ecosystem were rated as part of the 2009 State of the Sound report. The overall threat ratings as published in *Identification, Definition and Rating of Threats to the Recovery of Puget Sound, A Technical Memorandum to the State of the Sound 2009* are reproduced here. For ratings associated with specific threat-component pairs, please see the original 2009 publication

**Table A.4.2. 2009 Soundwide Threat Rating**

Threat	2009 Summary Threat Rating
Climate Change	Very High
Residential, Commercial, Port & Shipyard Development	Very High
Dams, Levees & Tidegates	High
Invasives- Terrestrial	High
Invasives-Freshwater	High
Non-Point Source Loading & Runoff	High
Roads, Transportation & Utility Infrastructure	High
Shoreline Armoring	High
Unsustainable Fishing / Harvesting	High
Air Pollution & Atmospheric Deposition	Medium
Invasives-Marine	Medium
Large Scale Timber Harvest	Medium
Oil & Hazardous Spills	Medium
Onsite Sewage Systems	Medium
Recreational Activities	Medium
Recreational Marinas	Medium
Water Withdrawals & Diversions	Medium
Agriculture & Livestock Grazing	Low

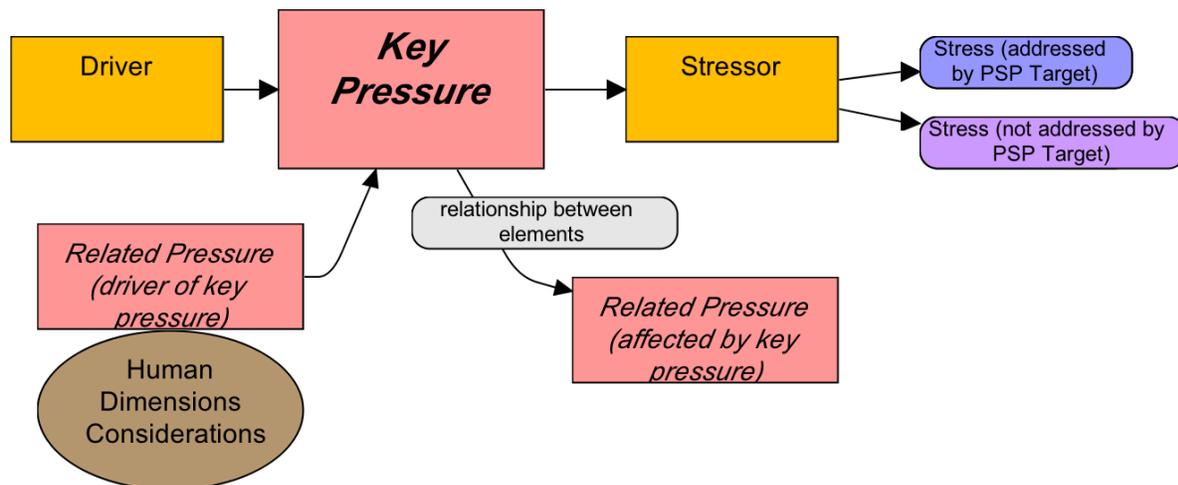
Threat	2009 Summary Threat Rating
Aquaculture	Low
Derelict Gear & Vessels	Low
Dredging & Dredged Material Disposal	Low
Military Exercises	Low
Mineral / Gravel Mining	Low
Point Source Pollution	Low
Vessel Traffic & Interaction	Low
Wastewater Treatment Plant Discharge & CSOs	Low
Agriculture & Livestock Grazing	Low
Aquaculture	Low
Derelict Gear & Vessels	Low
Dredging & Dredged Material Disposal	Low
Military Exercises	Low
Mineral / Gravel Mining	Low
Point Source Pollution	Low
Vessel Traffic & Interaction	Low
Wastewater Treatment Plant Discharge & CSOs	Low

## A.5. 2013 Pressure Classes

This section includes detailed descriptions of each of the 29 pressure classes. Information about each pressure class is presented as follows:

- Pressure definition
- Primary stressors
- Examples of common ecosystem stresses
- Related pressures
- Key drivers - factors beyond the scope of the project that are contributing to the existence or persistence of pressures to ecosystem components
- Human-ecosystem relationships - human benefits derived from actions associated with the pressure
- Pressure network diagram - a diagrammatic illustration of pathways of effect linking the key pressure to the stressors through which it acts on ecosystems or species, common ecosystem stresses, and other pressures, drivers and human dimensions considerations

### Pressure Network Diagrams Key



# 1. Residential & Commercial Development

Included in this category:

## 1.1 Residential & Commercial Development

### 1.1 Residential & Commercial Development

**Pressure definition:** *Residential & Commercial Development* addresses impacts associated with human settlements or other non-agricultural land uses with a substantial footprint, including residential, commercial, and industrial development. This includes pressures associated with new and existing development. This does not include shoreline armoring, overwater structures, transportation and utility infrastructure, port and shipyard development, or runoff associated with any developed areas. Pressures are primarily associated with the specific location, the extent, the density, the design, and the performance of development.

**Primary source(s):** In this taxonomy *Residential & Commercial Development* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Runoff from the Built Environment*, see also below)

**Primary stressors:** Stressors associated with the pressure *Residential & Commercial Development* as defined here include

- habitat conversion due to human land-use change
- pollution - air pollution

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Residential & Commercial Development* as defined here include but are not limited to

- reduced habitat extent in terrestrial, freshwater and nearshore systems
- degraded habitat quality, including reduced habitat connectivity, diversity, and structure, as well as degraded environmental conditions in terrestrial, freshwater and nearshore ecosystems
- reduced landscape connectivity (i.e. habitat corridor connectivity)
- altered abiotic and biotic dynamics, including altered hydrology and community composition

**Related pressures:** *Residential & Commercial Development* is related to other pressures in the taxonomy as an indirect pressure (aka. contributing factor or driver) as follows:

- increases *Runoff from the Built Environment*
- facilitates the introduction and movement of *Invasive Species & Genes*
- leads to an increased demand for *Freshwater Shoreline Infrastructure, Marine Shoreline Infrastructure, Freshwater Levees & Floodgates, Marine Shoreline Infrastructure, Industrial, Domestic & Municipal Wastewater, CSOs, OSS, Dams, Energy Production & Energy Emissions, Transportation & Service Corridors, Water Withdrawals & Diversions*

**Key drivers:** Market forces and population growth are key drivers of Residential & Commercial Development in the Puget Sound region.

**Human-ecosystem relationship:** *Residential & Commercial Development* contributes to human well being by sustaining the built environment that provides necessary infrastructure and jobs.

**Revisions since 2009:** The definition for *Residential & Commercial Development* was originally adapted from Salafsky et al (2008) and published as part of the threat taxonomy in the State of the Sound (S.O.S. 2009). Revisions to the 2009 definitions have included removal of elements of port and shipyard development, in-water development and log rafting as well as the addition of air emissions associated with development. Revisions were based on feedback on the 2009 threat taxonomy, the discussion of pressures and impacts associated with development in the Puget Sound Science Update (PSSU 2010, Ch. 3), and input from two workshops in May-June 2012 associated with Action Agenda strategy prioritization.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “Very High” but this rating is not consistent with the revised definition. The 2009 rating included pressures associated with port and shipyard development and *did not* include consideration of air emissions associated with new and existing development.

**Pressure network diagram:** The following diagram illustrates the relationships between Residential & Commercial Development and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 2. Agriculture & Aquaculture

Included in this category:

- 2.1 Agriculture
- 2.2 Livestock Grazing
- 2.3 Fin Fish Aquaculture
- 2.4 Shellfish Aquaculture
- 2.5 Timber Harvest

### 2.1 Agriculture

**Pressure definition:** *Agriculture* includes addresses impacts on ecosystem processes and human well being associated with methods or location of farming. This includes non-timber crops planted for food, fiber, and other uses, nurseries and their physical impacts to the soil, vegetation, associated surface water resources (i.e. runoff or effluent from agricultural lands), and ditching in support of agriculture and hobby farms. This does not include pressures associated with livestock grazing or water withdrawals in support of agriculture (see related pressures). Pressures are primarily associated with the location, intensity, and type of agriculture.

**Primary source(s):** In this taxonomy *Agriculture* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Invasive Species & Genes*, see also below)

**Primary stressors:** Stressors associated with *Agriculture* include

- habitat conversion due to human land-use change
- hydromodification - ditching
- pollution – delivery of toxics, nutrients, sediment, pathogens in water
- soil compaction

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Agriculture*

- reduced habitat extent of terrestrial, freshwater and nearshore ecosystems
- degraded habitat quality, including reduced habitat connectivity, diversity, and structure
- degraded water quality
- altered hydrology

**Related pressures:** *Agriculture* is related to other pressures in the taxonomy as an indirect pressure (aka. contributing factor or driver) as follows:

- facilitates the introduction and movement of *Invasive Species & Genes*
- leads to an increased demand for *Freshwater Shoreline Infrastructure, Marine Shoreline Infrastructure, Marine Levees & Tidegates, Freshwater Levees & Floodgates, Dams, Water Withdrawals*

**Key drivers:** Population growth and market forces are key drivers of *Agriculture*

**Human-ecosystem relationship:** *Agriculture* contributes to human well being in Puget Sound by sustaining social and cultural values and supporting local economies associated with working resource lands.

**Revisions since 2009:** The definition for *Agriculture* was originally adapted from Salafsky et al (2008). Based on feedback on the S.O.S. 2009 threat taxonomy, input from the process of developing the RITT's Common Framework for Chinook Recovery, and recommendations from the 2012 May-June workshops on strategy prioritization associated with the Action Agenda update, the following revisions were made: Livestock Grazing was removed to its own unique pressure class and runoff from agricultural lands is now included within this pressure.

**Status of Soundwide rating:** This pressure was most recently rated in 2012 as "Low" as part of the Action Agenda update process and addresses *Agriculture* as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Agriculture* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 2.2 Livestock Grazing

**Pressure definition:** *Livestock Grazing* addresses impacts on ecosystem processes and human well being associated with methods or location of livestock grazing activities. This includes domestic animals raised in one location and their physical impacts to the soil, vegetation, associated surface water resources (i.e. runoff or effluent from livestock grazing lands) and ditching. This does not include water withdrawals in support of livestock grazing. Pressures are primarily associated with location and intensity of livestock grazing.

**Primary source(s):** In this taxonomy *Livestock Grazing* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Invasive Species & Genes*, see also below)

**Primary stressors:** Stressors associated with *Livestock Grazing* include

- habitat conversion – due to human land-use change
- hydromodification - ditching
- pollution – delivery of toxics, nutrients, sediment, pathogens in water
- soil compaction
- pollution - air pollution

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Livestock Grazing*

- degraded habitat condition (connectivity, diversity, structure, etc) and function
- reduced habitat extent
- impaired water quality
- altered hydrology

**Related pressures:** *Livestock Grazing* is related to other pressures in the taxonomy as follows:

- facilitates the introduction and movement of *Invasive Species & Genes*
- leads to an increased demand for *Freshwater Levees & Floodgates, Marine Water Levees & Tidegates, Freshwater Shoreline Infrastructure and Marine Shoreline Infrastructure, Dams, Water Withdrawals*

**Key drivers:** Population growth and market forces are a key driver of *Livestock Grazing*.

**Human-ecosystem relationship:** *Livestock Grazing* contributes to human well being by supporting local economies.

**Pressure network diagram:** The following diagram illustrates the relationships between *Livestock Grazing* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

**Revisions since 2009:** The definition for *Livestock Grazing* was adapted from Salafsky et al (2008) and revised from 2009 based on input from workgroups convened by PSP in 2012 in support of strategy and action prioritization for the 2012 Action Agenda update. The 2009 single threat category *Agriculture and Livestock Grazing* was split into two separate pressures that could be rated independently.

Status of Soundwide rating: **This pressure was most recently rated in 2012 as “Low” and the rating addresses the pressure as currently defined.**

## 2.3 Fin Fish Aquaculture

**Pressure definition:** *Fin Fish Aquaculture* addresses impacts on ecosystem processes and human well being associated with the location, intensification, or practice of aquaculture. This includes both hatchery and farm approaches to fin fish aquaculture and it includes pressures associated with permanent and temporary structures.

**Primary source(s):** In this taxonomy *Fin Fish Aquaculture* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Invasive Species & Genes*, see also below)

**Primary stressors:** Stressors associated with *Fin Fish Aquaculture* include

- disease introduction
- habitat conversion – due to human land-use change
- increased competition - due to increased native species
- increased predation - due to increased native and introduced species
- pollution - delivery of toxics, nutrients, sediment, pathogens in water

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Fin Fish Aquaculture*

- reduced genetic diversity
- reduced abundance
- reduced fecundity
- reduced productivity
- degraded habitat condition (structural, shading)
- impaired water quality

**Related pressures:** *Fin Fish Aquaculture* is related to other pressures in the taxonomy as follows:

- facilitates introduction of *Invasive Species & Genes*
- leads to an increased demand for *Freshwater Shoreline Infrastructure* and *Marine Shoreline Infrastructure, Water Withdrawals & Diversions*

**Key drivers:** Market forces and population growth are a key driver of *Fin Fish Aquaculture*

**Human-ecosystem relationship:** *Fin Fish Aquaculture* contributes to human well being by supporting local economies and recreational activities. It is associated with important social and cultural values.

**Revisions since 2009:** The definition for *Fin Fish Aquaculture* was revised from the 2009 threat category *Aquaculture* based on feedback on the 2009 S.O.S. threat taxonomy. The current definition was adapted from Salafsky, et.al. (2008) and does not include shellfish aquaculture.

**Status of Soundwide rating:** The available rating of “Low” from 2009 does not address this pressure as currently defined. The 2009 rating addressed a single related pressure, *Aquaculture*, and did not consider fin fish and shellfish aquaculture separately.

**Pressure network diagram:** The following diagram illustrates the relationships between *Fin Fish Aquaculture* as defined here and associated stressors, stresses, related pressures and key drivers.

Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 2.4 Shellfish Aquaculture

**Pressure definition:** *Shellfish Aquaculture* addresses impacts on ecosystem processes and human well being associated with the location, intensification, or practice of aquaculture.

**Primary source(s):** In this taxonomy *Shellfish Aquaculture* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Invasive Species & Genes*, see also below)

**Primary stressors:** Stressors associated with *Shellfish Aquaculture* include

- habitat conversion - due to human land-use change
- increased predation - from introduced species
- pollution - delivery of nutrients, sediment, pathogens in water

**Common ecosystem stresses:** Direct impacts of *Shellfish Aquaculture* on Puget Sound ecosystems and species include but are not limited to

- reduced abundance of species
- impaired condition of species
- reduced genetic diversity of native populations
- degraded habitat condition (quality and connectivity) and function
- impaired water quality
- reduced habitat extent

**Related pressures:** *Shellfish Aquaculture* is related to other pressures in the taxonomy as follows:

- facilitates introduction of *Invasive Species & Genes*
- leads to an increased demand for *Freshwater Shoreline Infrastructure* and *Marine Shoreline Infrastructure*

**Key drivers:** Market forces and population growth are key drivers of *Shellfish Aquaculture*

**Human-ecosystem relationship:** *Shellfish Aquaculture* contributes to human well being as an important local marine industry and is associated with important regional social and cultural values

**Revisions since 2009:** The definition for *Shellfish Aquaculture* was revised from the 2009 threat category *Aquaculture* based on feedback on the 2009 S.O.S. threat taxonomy. The current definition was adapted from Salafsky, et.al. (2008) and does not include fin fish aquaculture.

**Status of Soundwide rating:** The available rating of “Low” from 2009 does not address this pressure as currently defined. The 2009 rating addressed a single related pressure, *Aquaculture*, and did not consider fin fish and shellfish aquaculture separately.

**Pressure network diagram:** The following diagram illustrates the relationships between *Shellfish Aquaculture* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 2.5 Timber Harvesting

**Pressure definition:** *Timber Harvesting* addresses impacts associated with consumptive uses of biological resources including deliberate and unintentional harvesting effects of timber practices and harvesting. This includes pollution carried in runoff from managed forest lands. This does not include infrastructure associated with forest practices (i.e. roads and culverts and associated impacts). This does not include water withdrawals associated with timber practices.

**Primary source(s):** In this taxonomy *Timber Harvest* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Invasive Species & Genes*, see also below)

**Primary stressors:** Stressors associated with *Timber Harvesting* include

- habitat conversion - human land-use change
- pollution - pesticide application
- hydromodification - storage, delivery, transport

**Common ecosystem stresses:** Direct impacts of *Timber Harvesting* on Puget Sound ecosystems and species include but are not limited to

- reduced habitat extent
- degraded habitat condition (diversity, connectivity, structure)
- altered hydrology and sediment dynamics
- altered nutrient and detritus supply
- degraded water quality
- impaired species condition

**Related pressures:** *Timber Harvesting* is related to other pressures in the taxonomy as follows:

- leads to an increased demand for *Transportation & Service Corridors, Culverts, Water Withdrawals & Diversions*

**Key drivers:** Market forces are a key driver of *Timber Harvesting*

**Human-ecosystem relationship:** *Timber Harvesting* contributes to human well being by supporting local economies.

**Revisions since 2009:** The definition for *Timber Harvesting* was adapted from Salafsky, et.al. (2008) and revised based on feedback on the 2009 S.O.S threat taxonomy. The 2009 definition was revised to include all timber harvest, not just large scale timber harvest, and language was added to clarify that this includes pollution carried in runoff from managed forest lands but not transportation infrastructure associated with forestry.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “Medium”. This rating does not address this pressure as currently defined; it only addressed large scale timber harvest and may not necessarily have included consideration of runoff from forest lands.

**Pressure network diagram:** The following diagram illustrates the relationships between *Timber*

*Harvesting* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

### 3. Energy Production & Mining

Pressures included in this category:

- 3.1 Energy Production & Energy Emissions
- 3.2 Mineral & Gravel Mining

#### 3.1 Energy Production & Energy Emissions

**Pressure definition:** *Energy Production & Energy Emissions* addresses impacts associated with the production and use of biological and nonbiological sources for energy consumption. This includes industrial and residential (e.g. smoke from wood stoves) sources of airborne pollutants.

**Primary source(s):** In this taxonomy *Energy Production & Mining* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Dams*, see also below). It is also influenced by other pressure sources in the taxonomy (e.g. *Residential & Commercial Development*, see also below)

**Primary stressors:** Stressors associated with *Energy Production & Energy Emissions* include

- pollution - air pollution
- pollution - atmospheric deposition

**Common ecosystem stresses:** Direct impacts of *Energy Production & Energy Emissions* on Puget Sound ecosystems and species include but are not limited to

- impaired condition of species
- impaired condition of invertebrate communities
- degraded water quality
- degraded habitat and sediment quality

**Related pressures:** *Energy Production & Energy Emissions* is related to other pressures in the taxonomy as follows:

- associated with number and demand on *Dams*
- contributes to contaminants in *Runoff from the Built Environment*
- *Residential & Commercial Development* and *Transportation & Service Corridors* lead to an increased demand for energy

**Key drivers:** Market forces, climate change and population growth are key drivers of *Energy Production & Energy Emissions*

**Human-ecosystem relationship:** *Energy Production & Energy Emissions* contributes to human well being by supporting residential, commercial and industrial energy needs.

**Revisions since 2009:** This pressure was not included in the 2009 threat taxonomy. The definition for *Energy Production & Energy Emissions* was adapted Salafsky, et.al. (2008) and revised based on feedback on the 2009 S.O.S. to include part of the 2009 *Air Pollution & Atmospheric Deposition* threat category as

well as human-generated emissions associated with energy production.

**Status of Soundwide rating:** This pressure has not yet been rated.

**Pressure network diagram:** The following diagram illustrates the relationships between *Energy Production & Energy Emissions* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 3.2 Mineral & Gravel Mining

**Pressure definition:** *Mineral & Gravel Mining* addresses impacts associated with the extraction of nonbiological resources. This includes air and water pollution associated with mining and related activities. This does not include extraction of gravel from river or streambeds or dredging.

**Primary source(s):** In this taxonomy *Mineral & Gravel Mining* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Water Withdrawals*, see also below).

**Primary stressors:** Stressors associated with *Mineral & Gravel Mining*

- habitat conversion - human land-use change
- pollution - toxics, nutrients, sediment, pathogens in water
- pollution – air pollution

**Common ecosystem stresses:** Direct impacts of *Mineral & Gravel Mining* to Puget Sound ecosystems and species include but are not limited to

- altered sediment dynamics
- altered hydrology
- impaired water quality
- reduced habitat extent
- degraded habitat condition
- impaired species condition

**Related pressures:** *Mineral & Gravel Mining* is related to other pressures in the taxonomy as follows:

- leads to an increased demand for *Transportation & Service Corridors*, *Water Withdrawals*
- *Energy Production & Energy Emissions*

**Key drivers:** Market forces are a key driver of *Mineral & Gravel Mining*

**Human-ecosystem relationship:** *Mineral & Gravel Mining* contributes to human well being by supporting local economies.

**Revisions since 2009:** The definition for *Mineral & Gravel Mining* was adapted from Salafsky, et.al (2008) and has been revised since 2009 to include contributions of air and water pollution from mining and related activities.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “Low”. However, the 2009 rating does not address this pressure as currently defined; air emissions are excluded.

**Pressure network diagram:** The following diagram illustrates the relationships between *Mineral & Gravel Mining* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 4. Transportation & Service Corridors

Pressures included in this category:

- 4.1 Transportation & Service Corridors
- 4.2 Dredging & Dredged Material

### 4.1 Transportation & Service Corridors

**Pressure definition:** *Transportation & Service Corridors* addresses impacts associated with the quantity and location of transportation and service networks, including boats, cars, trains & pipelines, and roads associated with timber harvest. This includes air pollution from vehicles and non-recreational vessels as well as direct discharge and damage from wakes and anchors from non-recreational vessels, including commercial transport, tourist ships, and whale-watching vessels in freshwater and marine waterways. This does not include runoff or accidental spills associated with transportation networks, derelict vessels, or pressures associated with recreational vessels. Pressures are typically associated with location, density, design, and materials of the corridors.

**Primary source(s):** In this taxonomy *Transportation & Service Corridors* is a pressure source. It is a source of multiple stressors (see below) and it acts as a source of other related pressures (e.g. *Water Freshwater Shoreline Infrastructure*, see also below). It is also directly influenced by other pressure sources in the taxonomy (e.g. *Residential & Commercial Development*).

**Primary stressors:** Stressors associated with *Transportation & Service Corridors*

- habitat conversion - due to human land-use change
- pollution - air pollution
- pollution - toxics, nutrients, sediment, pathogens in water
- species disturbance

**Common ecosystem stresses:** Direct impacts of *Transportation & Service Corridors* on Puget Sound ecosystems and species include but are not limited to

- reduced habitat extent
- degraded habitat quality (reduced connectivity, species diversity, etc) and function
- degraded air quality
- degraded water quality

**Related pressures:** *Transportation & Service Corridors* is related to other pressures in the taxonomy as follows:

- increases *Runoff from the Built Environment*
- leads to an increased demand for *Freshwater Shoreline Infrastructure*, *Marine Shoreline Infrastructure*, and *Culverts*
- *Residential & Commercial Development* drives the demand for transportation and service corridors

**Key drivers:** Market forces and population growth are key drivers of *Transportation & Service Corridors*

**Human-ecosystem relationship:** *Transportation & Service Corridors* contributes to human well-being by supporting marine industries, working resource lands and industries, and many other desirable human activities.

**Revisions since 2009:** The 2009 threat category *Roads, Transportation, Utility Infrastructure* was renamed *Transportation & Service Corridors* and revised based on Salafsky et al (2008), feedback on the 2009 S.O.S, and the 2010 PSSU. The pressure now includes all auto, plane and vessel traffic as well as emissions and air pollution associated with transportation and service corridors.

**Status of Soundwide rating:** This pressure was most recently rated as “High” in 2009 but this rating does not address this pressure as currently defined; air emissions are excluded.

**Pressure network diagram:** The following diagram illustrates the relationships between *Transportation & Service Corridors* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 4.2 Dredging & Dredged Material

**Pressure definition:** *Dredging & Dredged Material* addresses impacts associated with the dredging and disposal of material from river and harbor systems.

**Primary source(s):** In this taxonomy *Dredging & Dredged Material* is a source of multiple stressors (see below). It is also directly influenced by other pressure sources in the taxonomy (e.g. *Agriculture*, see also below).

**Primary stressors:** Stressors associated with *Dredging & Dredged Material* include

- habitat conversion - due to human land-use change
- pollution - release of legacy toxics

**Common ecosystem stresses:** Direct impacts of *Dredging & Dredged Material* on Puget Sound ecosystems and species include but are not limited to

- loss of habitat extent
- degraded habitat quality and function
- degraded water quality
- altered sediment dynamics

**Related pressures:** *Dredging & Dredged Material* is related to other pressures in the taxonomy as follows:

- *Agriculture and Transportation & Service Corridors* drive the demand for dredging

**Key drivers:** Market forces are key drivers of *Dredging & Dredged Material*

**Human-ecosystem relationship:** *Dredging & Dredged Material* contributes to human well being by supporting marine industries and other industries that rely on aquatic transportation corridors.

**Revisions since 2009:** The definition for *Dredging & Dredged Material* was retained from the 2009 threat taxonomy.

**Status of Soundwide rating:** The available rating of “Low” from 2009 addresses this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Dredging & Dredged Material* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 5. Biological Resource Use

Pressures included in this category:

- 5.1 Animal Harvesting (Aquatic)
- 5.2 Animal Harvesting (Terrestrial)

### 5.1 Animal Harvesting (Aquatic)

**Pressure definition:** *Animal Harvesting (Aquatic)* addresses impacts associated with consumptive uses of aquatic biological resources including deliberate and unintentional harvesting effects on wild, managed and cultivated species. This includes both recreational and commercial harvest. This does not include pressures associated with the direct impacts of aquaculture, derelict fishing gear or vessels, vessel traffic, or shoreline infrastructure.

**Primary source(s):** In this taxonomy *Animal Harvesting (Aquatic)* is a source of multiple stressors (see below) and related pressures (e.g. *Derelict Fishing Gear*). It is also directly influenced by other pressure sources in the taxonomy (e.g. *Aquaculture*, see also below).

**Primary stressors:** Stressors associated with *Animal Harvesting (Aquatic)* include

- bycatch
- harvest

**Common ecosystem stresses:** Direct impacts of *Animal Harvesting (Aquatic)* to Puget Sound ecosystems and species include but are not limited to

- reduced genetic diversity
- reduced abundance
- reduced fecundity
- reduced productivity

**Related pressures:** *Animal Harvesting (Aquatic)* is related to other pressures in the taxonomy as follows:

- increase amount of *Derelict Fishing Gear*
- *Fin Fish Aquaculture* supports aquatic animal harvest
- activities and facilities associated with animal harvesting (e.g. vessels and shoreline infrastructure) are covered within *Recreational activities*

**Key drivers:** Population growth, climate change and market forces are key drivers of *Animal Harvesting (Aquatic)*

**Human-ecosystem relationship:** *Animal Harvesting (Aquatic)* is associated with desirable nature-oriented recreation, important local industries, and regional social and cultural values.

**Revisions since 2009:** The definition for *Animal Harvesting (Aquatic)*, originally adapted from Salafsky, et.al (2008) was revised from the 2009 threat taxonomy to include all aquatic animal harvesting rather than focusing on “unsustainable” fishing. Revisions were primarily based on feedback on the 2009 threat

taxonomy.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “High” but the rating does not address this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Animal Harvesting (Aquatic)* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 5.2 Animal Harvesting (Terrestrial)

**Pressure definition:** *Animal Harvesting (Terrestrial)* includes impacts associated with consumptive uses of terrestrial biological resources including deliberate and unintentional harvesting effects on wild and managed species. This includes both recreational and commercial harvest.

**Primary source(s):** In this taxonomy, the pressure class *Animal Harvesting (Terrestrial)* represents both the source and the stressor.

**Primary stressors:** The single direct stressor associated *Animal Harvesting (Terrestrial)* is

- harvest

**Common ecosystem stresses:** Direct impacts of *Animal Harvesting (Terrestrial)* on Puget Sound ecosystems and species include but are not limited to

- reduced genetic diversity
- reduced abundance
- reduced fecundity
- reduced productivity

**Related pressures:** *Animal Harvesting (Terrestrial)* is related to other pressures in the taxonomy as follows:

- activities associated with animal harvesting (e.g. off-road vehicles) are included within *Recreational Activities*

**Key drivers:** Population growth is a key driver of *Animal Harvesting (Terrestrial)*

**Human-ecosystem relationship:** *Animal Harvesting (Terrestrial)* is associated with desirable nature-oriented recreation and regional social and cultural values.

**Revisions since 2009:** This pressure was not included in the 2009 threat taxonomy. The current definition for *Animal Harvesting (Terrestrial)* was adapted from Salasfky, et.al (2008).

**Status of Soundwide rating:** This pressure has not yet been rated.

**Pressure network diagram:** The following diagram illustrates the relationships between *Animal Harvesting (Terrestrial)* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 6. Human Intrusions & Disturbance

This pressure category focuses on pressures associated with human activities and the products of those activities. Structures and other infrastructure built to support human activities are the focus of other pressure categories (e.g. Natural System Modifications). Pressure classes included in this category:

- 6.1 Recreational Activities
- 6.2 Military Exercises
- 6.3 Derelict Fishing Gear

### 6.1 Recreational Activities

**Pressure definition:** *Recreational Activities* addresses impacts associated with human activities that alter, destroy, and disturb habitats and species associated with nonconsumptive uses of biological resources. This includes recreational vessels, off-road vehicles, and associated air and water pollution, but not NPDES-regulated hull-cleaning (see Pollution pressures). This does not include impacts from commercial whale-watching vessels (see *Transportation & Service Corridors*), commercial recreational activities, non-recreational boat discharge, marinas or transportation networks associated with recreational activities (see related pressures).

**Primary source(s):** In this taxonomy *Recreational Activities* is a source of multiple stressors (see below) and other pressures (e.g. *Invasive Species & Genes*, see also below). It is also directly influenced by other pressure sources in the taxonomy (e.g. *Animal Harvest*, see also below).

**Primary stressors:** Stressors associated with *Recreational Activities*

- habitat degradation - ?
- pollution - air pollution
- pollution - delivery of toxics, nutrients, sediment, pathogens in water
- species disturbance

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Recreational Activities*

- impaired species condition
- reduced species abundance
- degraded air quality and water quality
- degraded environmental conditions
- degraded habitat condition

**Related pressures:** *Recreational Activities* is related to other pressures in the taxonomy as follows:

- *Animal Harvesting (Aquatic and Terrestrial)* includes activities addressed within *Recreational Activities* (e.g. recreational fishing boats, off-road vehicles)
- facilitates introduction and movement of *Invasive Species & Genes*
- increases or is a source of *Residential & Commercial Development, Runoff from the Built*

*Environment, Toxics & Legacy Contaminants, and Derelict Fishing Gear*

- leads to an increased demand for *Transportation & Service Corridors, Marine Shoreline Infrastructure and Freshwater Shoreline Infrastructure*

**Key drivers:** Population growth and market forces are key drivers of *Recreational Activities*

**Human-ecosystem relationship:** *Recreational Activities* is typically associated with activities that are desirable and contribute to human health, human well-being and increasing awareness of Puget Sound ecosystems and species.

**Revisions since 2009:** The definition for *Recreational Activities* was revised from the 2009 threat taxonomy to include contributions of air and water pollution from recreational vessels and off-road vehicles and other recreational activities.

**Status of Soundwide rating:** The available rating of “Medium” from 2009 does not address this pressure as currently defined. Air emissions from recreational vehicles were not included in the 2009 rating.

**Pressure network diagram:** The following diagram illustrates the relationships between *Recreational Activities* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 6.2 Military Exercises

**Pressure definition:** *Military Exercises* addresses impacts associated with military exercises that alter, destroy, and disturb habitats and species. This does not include development, transportation or service infrastructure associated with permanent military bases.

**Primary source(s):** In this taxonomy *Military Exercises* is a source of multiple stressors (see below).

**Primary stressors:** Stressors associated with *Military Exercises* include

- habitat conversion - human land-use change
- habitat degradation – defoliation due to ?
- habitat degradation - ?
- pollution - munitions testing
- pollution - underwater bombs & testing

**Common ecosystem stresses:** Direct impacts of *Military Exercises* on Puget Sound ecosystems and species include but are not limited to

- loss of habitat extent
- degraded vegetation condition (defoliation due to ??)
- degraded habitat condition
- degraded water quality
- impaired species condition
- reduced species abundance

**Related pressures:** *Military Exercises* is not related to other pressures in the taxonomy

**Key drivers:** Federal policies are key drivers of *Military Exercises*

**Human-ecosystem relationship:** *Military Exercises* are associated with desirable activities such as protection of people and infrastructure.

**Revisions since 2009:** The definition for *Military Exercises* has not been revised from the 2009 threat taxonomy.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “Low” and the rating addresses the pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Military Exercises* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 6.3 Derelict Fishing Gear

**Pressure definition:** *Derelict Fishing Gear* addresses impacts associated with the presence of derelict gear and vessels, including destruction or degradation of habitats and disturbance of species. This does not include spills associated with derelict vessels.

**Primary source(s):** In this taxonomy, the pressure class *Derelict Fishing Gear* is equivalent to a stressor. The primary sources of *Derelict Fishing Gear* are

- *Animal Harvesting (Aquatic), Recreational Activities, and Transportation & Service Corridors*

**Primary stressors:** Stressors associated with *Derelict Fishing Gear* include

- derelict fishing gear and vessels

**Common ecosystem stresses:** Direct impacts of *Derelict Fishing Gear* to Puget Sound ecosystems and species include but are not limited to

- degraded habitat condition
- reduced species abundance

**Related pressures:** *Derelict Fishing Gear* is related to other pressures in the taxonomy as follows:

- *Animal Harvesting (Aquatic), Recreational Activities and Transportation & Service Corridors* are sources of derelict gear and vessels

**Key drivers:** Market forces are key drivers of *Derelict Fishing Gear*.

**Human-ecosystem relationship:** *Derelict Fishing Gear* is related to desirable human activities including recreational and commercial fishing and marine industries.

**Revisions since 2009:** The definition for *Derelict Fishing Gear* was retained from the 2009 threat. Language was added to clarify that this pressure includes derelict vessels.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “Low” and the rating addresses this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Derelict Fishing Gear* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix

## 7. Natural System Modifications

This category focuses on a subset of structural infrastructure put in place to support human activities.

Pressures included in this category:

- 7.1 Dams
- 7.2 Culverts
- 7.3 Freshwater Levees & Floodgates
- 7.4 Marine Levees & Tidegates
- 7.5 Marine Shoreline Infrastructure
- 7.6 Freshwater Shoreline Infrastructure

### 7.1 Dams

**Pressure definition:** *Dams* addresses impacts associated with actions that convert or degrade habitat or alter hydrology via putting in dams to manage how and when water flows through a system, often to improve human welfare.

**Primary source(s):** In this taxonomy *Dams* is a source of multiple stressors (see below) and other pressures (e.g. *Water Withdrawals & Diversions*, see also below). It is also directly influenced by other pressure sources in the taxonomy (e.g. *Energy Production & Energy Emissions*, see also below).

**Primary stressors:** Stressors associated with *Dams* include

- fish passage barriers
- habitat destruction - altered hydrology
- hydromodification - flow regulation
- hydromodification - structural barriers to water, sediment, debris flow

**Common ecosystem stresses:** Direct impacts of *Dams* on Puget Sound ecosystems and species include but are not limited to

- altered sediment dynamics
- altered hydrological dynamics
- altered nutrient or organic delivery
- reduced species abundance
- degraded habitat condition
- loss of habitat

**Related pressures:** *Dams* is related to other pressures in the taxonomy as follows:

- lead to increase in *Water Withdrawals & Diversions* and *Transportation & Service Corridors*
- *Energy Production & Energy Emissions* drive demand for dams

**Key drivers:** Market forces, and population growth are key drivers of the need for *Dams*

**Human-ecosystem relationship:** *Dams* contributes to human well being by supplying energy and water

for human populations and industries. *Dams* also provide some protection to human populations as flood management infrastructure.

**Revisions since 2009:** *Dams* was not included as a unique pressure in the 2009 threat taxonomy. In 2009, pressures associated with these structures were addressed within a broader pressure class including all dams, levees, tidegates, floodgates and culverts. Based on feedback on the 2009 S.O.S taxonomy, input from the 2010-2012 development of the Chinook Common Framework, and discussions of these pressures in the 2010 PSSU, the 2009 threat *Dams, Levees and Tidegates* was divided into four unique pressures addressing different types of marine and freshwater hydromodification.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. In 2009, a single related pressure, *Dams, Levees, and Tidegates*, was rated “High”.

**Pressure network diagram:** The following diagram illustrates the relationships between *Dams* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 7.2 Culverts

**Pressure definition:** *Culverts* addresses impacts associated with the installation and presence of culverts to manage the flow and passage of water, sediment, and species.

**Primary source(s):** In this taxonomy *Culverts* is a source of multiple stressors (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Timber Harvesting*, see also below).

**Primary stressors:** Stressors associated with *Culverts* include

- fish passage barriers
- hydromodification - structural barriers to water, sediment, debris flow

**Common ecosystem stresses:** Direct impacts of *Culverts* on Puget Sound ecosystems and species include but are not limited to

- reduced species abundance
- impaired condition of species
- altered hydrological dynamics
- altered sediment dynamics
- degraded habitat condition or function

**Related pressures:** *Culverts* is related to other pressures in the taxonomy as follows:

- *Transportation & Service Corridors, Timber Harvesting and Residential & Commercial Development* drive the need for culverts

**Key drivers:** Population growth and market forces are key drivers of *Culverts*

**Human-ecosystem relationship:** *Culverts* contributes human well-being by supporting built infrastructure and local industries.

**Revisions since 2009:** *Culverts* was not included as a unique pressure in the 2009 threat taxonomy. In 2009, pressures associated with these structures were addressed within a broader pressure class including all dams, levees, tidegates, floodgates and culverts. Based on feedback on the 2009 S.O.S taxonomy, input from the 2010-2012 development of the Chinook Common Framework, and discussions of these pressures in the 2010 PSSU, the 2009 threat *Dams, Levees and Tidegates* was divided into four unique pressures addressing different types of marine and freshwater hydromodification.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. In 2009, a single related pressure, *Dams, Levees, and Tidegates*, was rated “High”.

**Pressure network diagram:** The following diagram illustrates the relationships between *Culverts* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 7.3 Freshwater Levees & Floodgates

**Pressure definition:** *Freshwater Levees & Floodgates* addresses impacts associated with actions that convert or degrade habitat or alter hydrology via establishing levees and floodgates along freshwater systems to manage the hydrologic flow in a system, often to improve human welfare.

**Primary source(s):** In this taxonomy *Freshwater Levees & Floodgates* is a source of multiple stressors (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Agriculture*, see also below).

**Primary stressors:** Stressors associated with *Freshwater Levees & Floodgates*

- fish passage barriers
- habitat destruction - due to altered hydrology
- hydromodification - structural barriers to water, sediment, debris flow

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Freshwater Levees & Floodgates*

- reduced habitat extent
- altered hydrological dynamics
- altered sediment dynamics
- altered nutrient/organic dynamics
- reduced habitat connectivity
- reduced species abundance

**Related pressures:** *Freshwater Levees & Floodgates* is related to other pressures in the taxonomy as follows:

- *Agriculture* and *Residential & Commercial Development* create demand for levees and floodgates

**Key drivers:** Climate change, population growth and market forces are key drivers of the need for *Freshwater Levees & Floodgates*

**Human-ecosystem relationship:** *Freshwater Levees & Floodgates* contributes to human well being by protecting property and people through provision of flood management and drainage services.

**Revisions since 2009:** *Freshwater Levees & Floodgates* was not included as a unique pressure in the 2009 threat taxonomy. In 2009, pressures associated with these structures were addressed within a broader pressure class including all dams, levees, tidegates, floodgates and culverts. Based on feedback on the 2009 S.O.S taxonomy, input from the 2010-2012 development of the Chinook Common Framework, and discussions of these pressures in the 2010 PSSU, the 2009 threat *Dams, Levees and Tidegates* was divided into four unique pressures addressing different types of marine and freshwater hydromodification.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. In 2009, a single related pressure, *Dams, Levees, and Tidegates*, was rated "High".

**Pressure network diagram:** The following diagram illustrates the relationships between *Freshwater Levees & Floodgates* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 7.4 Marine Water Levees & Tidegates

**Pressure definition:** *Marine Water Levees & Tidegates* addresses impacts associated with actions that convert or degrade habitat or alter hydrology via establishing levees & tidegates along marine water systems to manage or exclude marine water into the freshwater system, often to improve human welfare.

**Primary source(s):** In this taxonomy *Marine Water Levees & Tidegates* is a source of multiple stressors (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Agriculture*, see also below).

**Primary stressors:** Stressors associated with *Marine Water Levees & Tidegates* include

- fish passage barriers
- habitat destruction - due to altered hydrology
- hydromodification - structural barriers to water, sediment, debris flow

**Common ecosystem stresses:** Direct impacts of *Marine Water Levees & Tidegates* on Puget Sound ecosystems and species include but are not limited to

- reduced habitat extent
- degraded habitat condition and function
- altered hydrological dynamics
- altered sediment dynamics
- altered nutrient/organic dynamics
- reduced species abundance

**Related pressures:** *Marine Water Levees & Tidegates* is related to other pressures in the taxonomy as follows:

- *Agriculture*, and *Residential & Commercial Development* create demand for marine water levees and tidegates

**Key drivers:** Climate change, population growth and market forces are key drivers of the need for *Marine Water Levees & Tidegates*

**Human-ecosystem relationship:** *Marine Water Levees & Tidegates* are primarily associated with flood management and drainage management and serve to protect people and built infrastructure.

**Revisions since 2009:** *Marine Water Levees & Tidegates* was not included as a unique pressure in the 2009 threat taxonomy. In 2009, pressures associated with these structures were addressed within a broader pressure class including all dams, levees, tidegates, floodgates and culverts. Based on feedback on the 2009 S.O.S taxonomy, input from the 2010-2012 development of the Chinook Common Framework, and discussions of these pressures in the 2010 PSSU, the 2009 threat *Dams, Levees and Tidegates* was divided into four unique pressures addressing different types of marine and freshwater hydromodification.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. In

2009, a single related pressure, *Dams, Levees, and Tidegates*, was rated “High”.

**Pressure network diagram:** The following diagram illustrates the relationships between *Marine Water Levees & Tidegates* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 7.5 Marine Shoreline Infrastructure

**Pressure definition:** *Marine Shoreline Infrastructure* addresses impacts associated with the armoring of marine shorelines and overwater structures that alter, destroy, and disturb habitats and species via a nonconsumptive use, including industrial, commercial and recreational marinas and barge landings, ports and shipyards. This includes air pollution from shoreline facilities. This does not include runoff from impervious surfaces or other water pollution and it does not include pressures associated with vessel traffic.

If useful for the purposes of developing pathways of effect at the soundwide or subregional scale, this pressure class could be divided into two subclasses addressing infrastructure associated with residential development (7.5.1) and infrastructure associated with non-residential development (7.5.2).

**Primary source(s):** In this taxonomy *Marine Shoreline Infrastructure* is a source of multiple stressors (see below) and it is a current and historic source of other pressures (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Agriculture*, see also below).

**Primary stressors:** Stressors associated with *Marine Shoreline Infrastructure* include

- habitat conversion - due to human land-use change
- increased predation - due to overwater structures and shading
- overwater structures
- shoreline armoring

**Common ecosystem stresses:** Direct impacts of *Marine Shoreline Infrastructure* on Puget Sound ecosystems and species include but are not limited to

- reduced habitat extent
- altered hydrological and sediment dynamics
- altered nutrient and detritus delivery
- degraded habitat condition and function
- reduced species abundance

**Related pressures:** *Marine Shoreline Infrastructure* is related to other pressures in the taxonomy as follows

- increases *Runoff from Built Environment*
- is a historic source of *Toxics & Legacy Contaminants*
- *Residential & Commercial Development, Agriculture, Transportation & Service Corridors, and Recreational Activities* drive the demand for marine shoreline infrastructure

**Key drivers:** Climate change, market forces and population growth are key drivers of *Marine Shoreline Infrastructure*

**Human-ecosystem relationship:** *Marine Shoreline Infrastructure* is typically associated with desirable human activities such as protection of property, people and industries with shoreline armoring or providing access to aquatic resources with docks and marinas.

**Revisions since 2009:** This pressure was not included in the 2009 threat taxonomy. The current

definition for *Marine Shoreline Infrastructure* combines elements of two 2009 threats, *Shoreline Armoring* and *Residential, Commercial, Port and Shipyard Development*. The current definition was adapted from Salafsky, et.al (2008) and includes input from feedback on the 2009 threat taxonomy, the Department of Ecology and the 2012 RITT Common Framework for Chinook Recovery.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. In 2009, related threats *Shoreline Armoring*, *Recreational Marinas*, and *Residential, Commercial, Port & Shipyard Development* were rated separately.

**Pressure network diagram:** The following diagram illustrates the relationships between *Marine Shoreline Infrastructure* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 7.6 Freshwater Shoreline Infrastructure

**Pressure definition:** *Freshwater Shoreline Infrastructure* addresses impacts associated with the armoring of freshwater shorelines and overwater structures that alter, destroy, and disturb habitats and species via a nonconsumptive use, including industrial, commercial, and recreational marinas, ports and shipyards. This includes air pollution from shoreline facilities. This does not include runoff from impervious surfaces or other water pollution and this does not include impacts associated with vessels.

If useful for the purposes of developing pathways of effect at the Soundwide or subregional scale, this pressure class could be divided into two subclasses addressing infrastructure associated with residential development (7.6.1) and infrastructure associated with non-residential development (7.6.2).

**Primary source(s):** In this taxonomy *Freshwater Shoreline Infrastructure* is a source of multiple stressors (see below) and is a current and historic source of other pressures (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Agriculture*, see also below).

**Primary stressors:** Stressors associated with *Freshwater Shoreline Infrastructure*

- habitat conversion - due to human land-use change
- increased predation - due to overwater structures and shading
- overwater structures
- shoreline armoring

**Common ecosystem stresses:** Direct impacts of *Freshwater Shoreline Infrastructure* on Puget Sound ecosystems and species include but are not limited to

- reduced habitat extent
- degraded habitat condition and function
- altered sediment and hydrological dynamics
- altered nutrient and detritus delivery
- reduced species abundance

**Related pressures:** *Freshwater Shoreline Infrastructure* is related to other pressures in the taxonomy as follows:

- increases *Runoff from Built Environment*
- is a historic source of *Toxics & Legacy Contaminants*
- *Residential & Commercial Development, Agriculture, Transportation & Service Corridors, and Recreational Activities* drive the demand for freshwater shoreline infrastructure

**Key drivers:** Climate change, market forces and population growth are key drivers of *Freshwater Shoreline Infrastructure*

**Human-ecosystem relationship:** *Freshwater Shoreline Infrastructure* is typically associated with desirable human activities such as protection of property and people with shoreline armoring or providing access to aquatic resources with docks and marinas.

**Revisions since 2009:** This pressure was not included in the 2009 threat taxonomy. The current definition for *Freshwater Shoreline Infrastructure* combines elements of two 2009 threats, *Shoreline Armoring* and *Recreational Marinas*. The current definition was adapted from Salafsky, et.al (2008) and includes input from feedback on the 2009 threat taxonomy, the Department of Ecology and the 2012 RITT Common Framework for Chinook Recovery.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. In 2009, related threats *Shoreline Armoring*, *Recreational Marinas*, and *Residential, Commercial, Port & Shipyard Development* were rated separately.

**Pressure network diagram:** The following diagram illustrates the relationships between *Freshwater Shoreline Infrastructure* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix

## 8. Invasives & Other Problematic Species & Genes

Pressures included in this category:

### 8.1 Invasive Species (Aquatic, Terrestrial)

#### 8.1 Invasive Species (Aquatic, Terrestrial)

**Pressure definition:** *Invasive Species* addresses impacts associated with the introduction and movement of non-native species or genes that are capable of aggressively establishing or causing environmental damage. This pressure includes marine, freshwater and terrestrial invasive species.

**Primary source(s):** In this taxonomy *Invasive Species* is a source of multiple stressors (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Agriculture*, see also below).

**Primary stressors:** Stressors associated with *Invasive Species* include

- increased competition - due to increased abundance of non-native species
- introduced genetic material
- habitat degradation – due to changed biotic and abiotic dynamics

**Common ecosystem stresses:** Stresses to ecosystem components associated with *Invasive Species*

- reduced abundance of native species
- impaired condition of native species
- altered hydrological and sediment dynamics
- degraded habitat condition
- reduced habitat extent

**Related pressures:** *Invasive Species* is related to other pressures in the taxonomy as follows:

- *Aquaculture (Fin fish and Shellfish)*, *Agriculture* and *Livestock Grazing* are sources of invasive species
- *Residential & Commercial Development*, *Transportation & Service Corridors*, *Recreational Activities*, and *Timber Harvesting* facilitate the introduction of invasive species

**Key drivers:** Market forces are a key driver of *Invasive Species*

**Human-ecosystem relationship:** *Invasive Species* are typically associated with activities that contribute to human well-being such as necessary infrastructure and services, industries and local economies, and recreational activities.

**Revisions since 2009:** The current pressure *Invasive Species* combines three invasive species categories from the 2009 threat taxonomy, marine, freshwater, and terrestrial invasive species. Revisions were based on feedback on the 2009 threat taxonomy.

**Status of Soundwide rating:** There is not a rating available for this pressure as currently defined. The available ratings from 2009 addressed 3 separate pressures associated with marine, freshwater and

terrestrial invasive species, rated “Medium”, “High” and “High”, respectively.

**Pressure network diagram:** The following diagram illustrates the relationships between *Invasive Species* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 9. Pollution

Pressures included in this category:

- 9.1 Runoff from the Built Environment
- 9.2 Industrial, Domestic & Municipal Wastewater
- 9.3 Onsite Sewage Systems (OSS)
- 9.4 Combines Sewer Overflows (CSOs)
- 9.5 Toxics & Legacy Contaminants
- 9.6 Oil & Hazardous Spills

### 9.1 Runoff from the Built Environment

**Pressure definition:** *Runoff from the Built Environment* addresses impacts associated with the introduction of exotic materials (e.g., chemicals & radionuclides) or excess native materials (e.g. sediment) into hydrologic systems due to surface water loading and runoff from the built environment. The "built environment" includes commercial, residential, and industrial lands and transportation facilities and corridors. This includes hull-cleaning and other pollution from marina infrastructure and land-based boat maintenance practices (i.e. NPDES regulated activities that occur in marinas and shipyards). This does not include loading from septic systems (OSS), combined sewer overflows (CSOs), or runoff from other activities (e.g., agriculture, timber harvest).

**Primary source(s):** In this taxonomy *Runoff from the Built Environment* is a source of multiple stressors (see below). It is also directly influenced by other pressures in the taxonomy (e.g. *Residential & Commercial Development*, see also below).

**Primary stressors:** Stressors associated with *Runoff from the Built Environment* include

- hydromodification - altered volume and timing of runoff
- pollution – delivery of toxics, nutrients, sediment, pathogens in water

**Common ecosystem stresses:** Direct impacts of *Runoff from the Built Environment* on Puget Sound ecosystems and species include but are not limited to

- impaired water quality
- degraded sediment habitat
- altered hydrological dynamics
- altered sediment dynamics

**Related pressures:** *Runoff from the Built Environment* is related to other pressures in the taxonomy as follows:

- *Residential & Commercial Development* and *Transportation & Service Corridors* are the primary sources of runoff

**Key drivers:** Population growth and market forces are key drivers of *Runoff from the Built Environment*

**Human-ecosystem relationship:** *Runoff from the Built Environment* contributes to human well being ...

The built environment offers many benefits for human health and well being, along with specific species of animals/plants (e.g. crows)

**Revisions since 2009:** The definition from the 2009 threat taxonomy has been retained but the name has been changed from *Non-point Source Loading and Runoff* to *Runoff from the Built Environment*. The 2009 definition was adapted from Salafsky, et.al (2008) and language has been added to clarify that this includes runoff from all of the built environment but not rural resource lands.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “High” and the available rating addresses this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Runoff from the Built Environment* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 9.2 Industrial, Domestic & Municipal Wastewater

**Pressure definition:** *Industrial, Domestic & Municipal Wastewater* addresses impacts associated with discharge from municipal and industrial wastewater treatment plants into hydrologic systems. This includes water-borne sewage that includes nutrients, pathogens, toxic chemicals, and sediments. This pressure does not include discharge from municipal combined sewer overflows (CSOs), onsite sewage systems (OSS), wastewater discharged from recreational and other vessels, or biosolids applied in terrestrial environments.

**Primary source(s):** In this taxonomy *Industrial, Domestic & Municipal Wastewater* is a source of multiple stressors (see below).

**Primary stressors:** Stressors associated with *Industrial, Domestic & Municipal Wastewater*

- pollution - toxics, nutrients, sediment, pathogens in water

**Common ecosystem stresses:** Direct impacts of *Industrial, Domestic & Municipal Wastewater* on Puget Sound ecosystems and species include but are not limited to

- Impaired water quality
- Degraded sediment habitat

**Related pressures:** *Residential & Commercial Development* drives demand for *Industrial, Domestic & Municipal Wastewater*.

**Key drivers:** Population growth is an indirect driver of the need for *Industrial, Domestic & Municipal Wastewater*

**Human-ecosystem relationship:** *Industrial, Domestic & Municipal Wastewater* contributes to human well being by protecting people and natural resources from toxics and contaminants associated with human waste.

**Revisions since 2009:** The definition for *Industrial, Domestic & Municipal Wastewater* was adapted from Salafsky, et al (2008) and has been revised since 2009 to remove CSOs. Revisions to the 2009 threat description were based on feedback on the 2009 S.O.S technical memorandum, input from the interdisciplinary team convened by PSP in 2011 to identify recovery targets, strategies and actions associated with wastewater pressures to Puget Sound, as well as input from workgroups convened by PSP in 2012 in support of strategy and action prioritization for the 2012 Action Agenda update.

**Status of Soundwide rating:** This pressure was most recently rated in 2012 as “Low” and the available rating from June 2012 addresses this pressure as currently defined. Note that the rating of the potential risk posed by this pressure assumes current management practices are maintained.

**Pressure network diagram:** The following diagram illustrates the relationships between *Industrial, Domestic & Municipal Wastewater* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

### 9.3 Onsite Sewage Systems (OSS)

**Pressure definition:** *Onsite Sewage Systems* addresses impacts associated with discharges from onsite sewage systems (OSS). This includes sewage and leachates (nutrients, toxic chemicals or sediment) from residences not connected to a municipal system. This includes large and small septic systems, small private systems, and everything with a drain field.

**Primary source(s):** In this taxonomy *Onsite Sewage Systems* is a source of related stressors (see below).

**Primary stressors:** Stressors associated with *Onsite Sewage Systems* include

- pollution – delivery of toxics, nutrients, sediment, pathogens in water

**Common ecosystem stresses:** Direct impacts of *Onsite Sewage Systems* on Puget Sound ecosystems and species include but are not limited to

- Impaired water quality
- Degraded sediment habitat

**Related pressures:** *Residential & Commercial Development* drives demand for *Onsite Sewage Systems*.

**Key drivers:** Population growth is an indirect driver of the need for *Onsite Sewage Systems*

**Human-ecosystem relationship:** *Onsite Sewage Systems* contributes to human well being by protecting people and natural resources from toxics and contaminants associated with human waste.

**Revisions since 2009:** The definition for *Onsite Sewage Systems (OSS)* was retained from the 2009 threat taxonomy. Keeping OSS separate from related pressures *Combined Sewer Overflows* and *Industrial, Commercial and Municipal Wastewater* is consistent with recommendations from the interdisciplinary team convened by PSP in 2011 to identify recovery targets, strategies and actions associated with wastewater pressures to Puget Sound, as well as input from workgroups convened by PSP in 2012 in support of strategy and action prioritization for the 2012 Action Agenda update.

**Status of Soundwide rating:** This pressure was most recently rated in 2009 as “Medium” and the rating addresses the pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Onsite Sewage Systems* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 9.4 Combined Sewer Overflows (CSOs)

**Pressure definition:** *Combined Sewer Overflows* addresses impacts associated with discharge from municipal combined sewer overflows (CSOs).

**Primary source(s):** In this taxonomy *Combined Sewer Overflows* is a source of related stressors (see below). It is also directly related to other pressures in the taxonomy (e.g. *Runoff from the Built Environment*, see also below).

**Primary stressors:** Stressors associated with *Combined Sewer Overflows* include

- pollution – delivery of toxics, nutrients, sediment, pathogens in water

**Common ecosystem stresses:** Direct impacts of *Combined Sewer Overflows* on Puget Sound ecosystems and species include but are not limited to

- Impaired water quality
- Degraded sediment habitat

**Related pressures:** *Combined Sewer Overflows* is related to other pressures in the taxonomy as follows:

- *Residential & Commercial Development*, *Runoff from the Built Environment*, and *Industrial, Domestic & Municipal Wastewater* are sources of input to CSOs

**Key drivers:** Population growth is an indirect driver of discharge from *Combined Sewer Overflows*.

**Human-ecosystem relationship:** *Combined Sewer Overflows* were originally designed as part of wastewater and stormwater management systems to protect people and built infrastructure. They are actively being retrofitted and replaced to improve waste and water management and reduce negative impacts on people and Puget Sound ecosystems and species.

**Revisions since 2009:** This pressure was not included in the 2009 S.O.S threat taxonomy. The current definition for *Combined Sewer Overflows* was developed based on feedback on the 2009 taxonomy from an interdisciplinary team convened by PSP in 2011 to identify recovery targets, strategies and actions associated with wastewater pressures to Puget Sound, as well as input from workgroups convened by PSP in 2012 in support of strategy and action prioritization for the 2012 Action Agenda update.

**Status of Soundwide rating:** This pressure was most recently rated in 2012 as “Low” and the rating addresses this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Combined Sewer Overflows* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 9.5 Toxics & Legacy Contaminants

**Pressure definition:** *Toxics & Legacy Contaminants* addresses impacts associated with the existence and persistence of contaminated soils and lands. This includes sources and pathways of toxic loading from brownfields and superfund sites as well as legacy contaminants that are already located in hydrologic systems, that reach hydrologic systems via groundwater, or that directly harm terrestrial systems.

**Primary source(s):** In this taxonomy, the pressure class *Toxics & Legacy Contaminants* is equivalent to a stressor. The primary historic sources of legacy toxics and contaminants are

- *Runoff from the Built Environment, Energy Production & Energy Emissions, Dredging & Dredged Material, Agriculture, Timber Harvesting, Industrial, Domestic & Municipal Wastewater, and Military Exercises*

**Primary stressors:** *Toxics & Legacy Contaminants* is itself a stressor.

- toxics in environment

**Common ecosystem stresses:** Direct impacts of *Toxics & Legacy Contaminants* on Puget Sound ecosystems and species include but are not limited to

- impaired water quality
- degraded sediment habitat
- impaired benthic invertebrate communities
- impaired species condition

**Related pressures:** *Toxics & Legacy Contaminants* is related to other pressures in the taxonomy as follows:

- *Runoff from the Built Environment, Energy Production & Energy Emissions, Dredging & Dredged Material, Agriculture, Timber Harvesting, Industrial, Domestic & Municipal Wastewater, and Military Exercises* are all sources of legacy toxics and contaminants

**Key drivers:** No current drivers identified

**Human-ecosystem relationship:** No current beneficial relationships for *Toxics & Legacy Contaminants* identified.

**Revisions since 2009:** This pressure was not included in the 2009 threat taxonomy. The current definition for *Toxics & Legacy Contaminants* was adapted from Salafsky et al (2008) with input from feedback on the 2009 S.O.S technical memo and the 2012 Action Agenda update process.

**Status of Soundwide rating:** This pressure was most recently rated in 2012 as “Low” and the rating addresses this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Toxics & Legacy Contaminants* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 9.6 Oil & Hazardous Spills

**Pressure definition:** *Oil & Hazardous Spills* addresses impacts associated with moderate and large accidental spills of oil and hazardous waste in aquatic and terrestrial environments. This includes episodic events only and does not include chronic or other pollution from stormwater runoff, wastewater treatment plants, CSOs, OSS, or other contaminant sources.

**Primary source(s):** In this taxonomy, the pressure class *Oil & Hazardous Spills* is equivalent to a stressor. The primary sources of *Oil & Hazardous Spills* are

- *Energy Production & Energy Emissions* and *Transportation & Service Corridors*

**Primary stressors:** *Oil & Hazardous Spills* is itself a stressor.

- toxic spills

**Common ecosystem stresses:** Direct impacts of *Oil & Hazardous Spills* on Puget Sound ecosystems and species include but are not limited to

- species mortality
- impaired species condition
- habitat degradation or destruction
- impaired water quality

**Related pressures:** *Oil & Hazardous Spills* is related to other pressures in the taxonomy as follows:

- *Transportation & Service Corridors* and *Energy Production & Energy Emissions* are sources of spills

**Key drivers:** Market forces are key drivers of *Oil & Hazardous Spills*

**Human-ecosystem relationship:** *Oil & Hazardous Spills* are associated with activities necessary to sustain human populations, industries and local economies.

**Revisions since 2009:** The definition for *Oil & Hazardous Spills* has been retained from the 2009 threat taxonomy. Additional language has been added to clarify that this pressure only refers to moderate and large episodic events not chronic contribution of these contaminants from automobiles, small boats, etc.

**Status of Soundwide rating:** This pressure was most recently rated in June 2012 as “Low” and the rating addresses this pressure as currently defined.

**Pressure network diagram:** The following diagram illustrates the relationships between *Oil & Hazardous Spills* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

## 10. Water Withdrawals & Diversions

Pressures included in this category:

### 10.1 Water Withdrawals & Diversions

#### 10.1 Water Withdrawals & Diversions

**Pressure definition:** *Water Withdrawals & Diversions* addresses impacts associated with the modification, extraction, or diversion of surface and groundwater supplies, including water withdrawals and diversions associated with agriculture and forestry practices. This includes changing water flow patterns, such as instream flows, from their natural range of variation deliberately as a result of water supply or flood management operations.

**Primary source(s):** In this taxonomy *Water Withdrawals & Diversions* is a source of related stressors (see below). The primary sources of demand for *Water Withdrawals & Diversions* are

- *Residential & Commercial Development, Agriculture, Livestock Grazing, and Timber Harvest*

**Primary stressors:** Stressors associated with *Water Withdrawals & Diversions* include

- hydromodification - water extraction
- hydromodification - water diversion

**Common ecosystem stresses:** Direct impacts of *Water Withdrawals & Diversions* on Puget Sound ecosystems and species include but are not limited to

- reduced water volume - groundwater
- reduced water volume - surface flows
- impaired water quality
- habitat degradation
- reduced habitat extent

**Related pressures:** *Water Withdrawals & Diversions* is related to other pressures in the taxonomy as follows:

- *Residential & Commercial Development, Agriculture, Livestock Grazing, and Timber Harvest* are sources of demand for *Water Withdrawals & Diversions*

**Key drivers:** Population growth and market forces are key drivers of *Water Withdrawals & Diversions*.

**Human-ecosystem relationship:** *Water Withdrawals & Diversions* sustain human populations directly and indirectly through supporting local industries and natural-resource based economies.

**Revisions since 2009:** The definition for *Water Withdrawals & Diversions* has not been changed since 2009 but additional language has been added to clarify that this pressure addresses water withdrawals and diversions for all purposes, including agriculture and forestry.

**Status of Soundwide rating:** This pressure was most recently rated as “Medium” in 2009 and does not

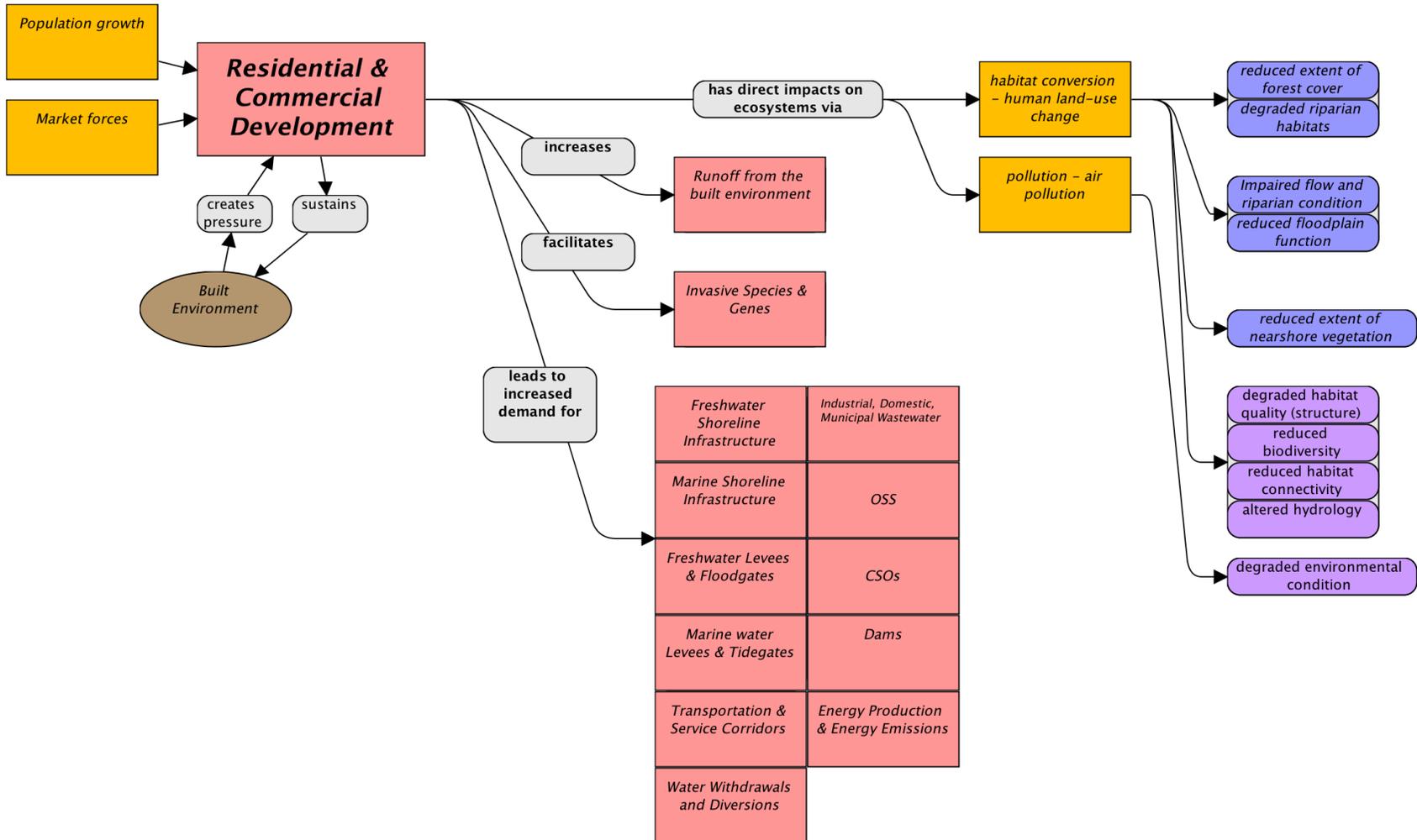
address withdrawals and diversions for all uses.

**Pressure network diagram:** The following diagram illustrates the relationships between *Water Withdrawals & Diversions* as defined here and associated stressors, stresses, related pressures and key drivers. Additional information about this pressure and related elements can be found in the tables in the Appendix.

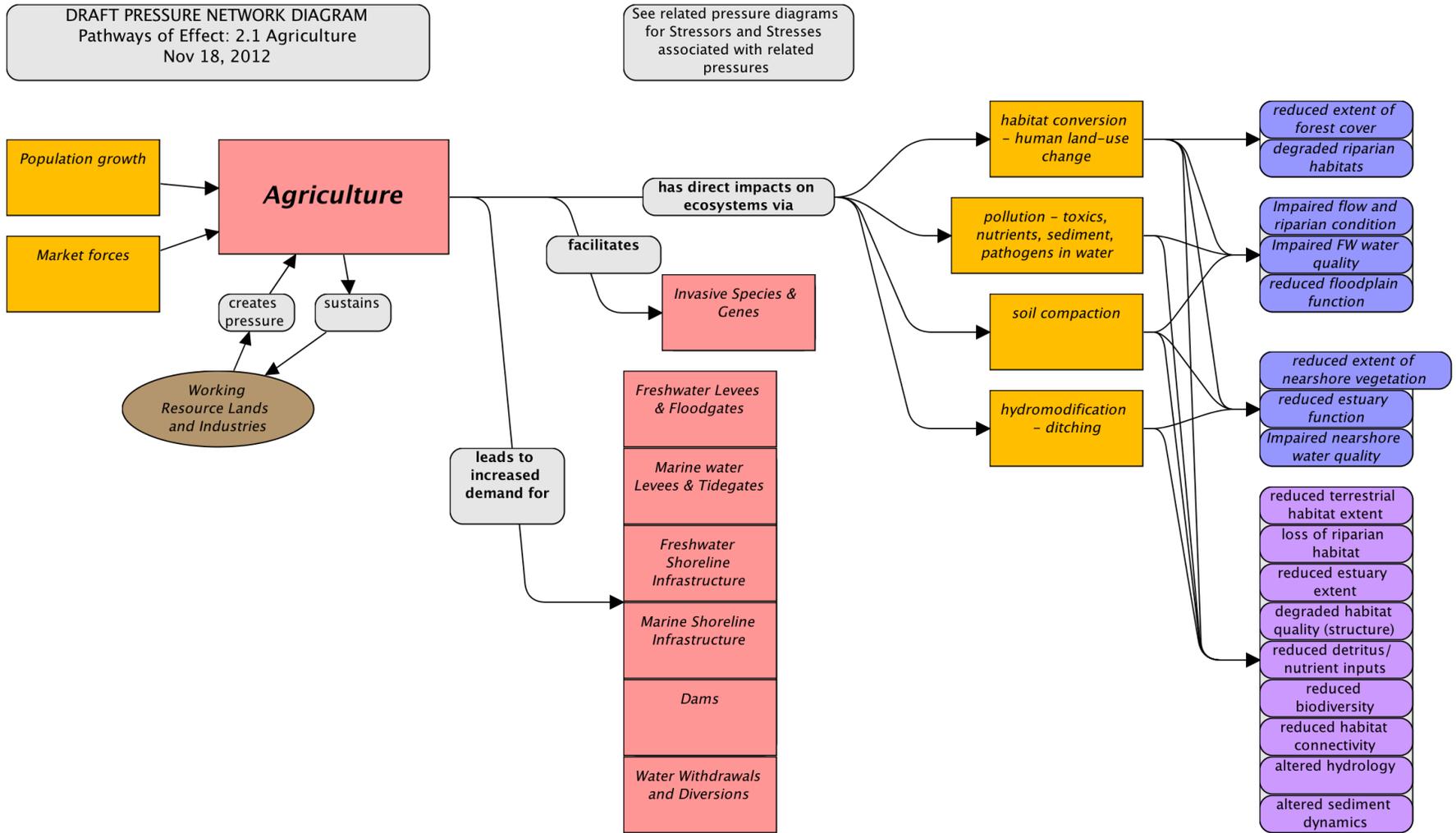
**Figure 1.1 Residential & Commercial Development Pressure Network Diagram**

DRAFT PRESSURE NETWORK DIAGRAM  
 Pathways of Effect: 1.1 Residential and Commercial Development  
 Nov 18, 2012

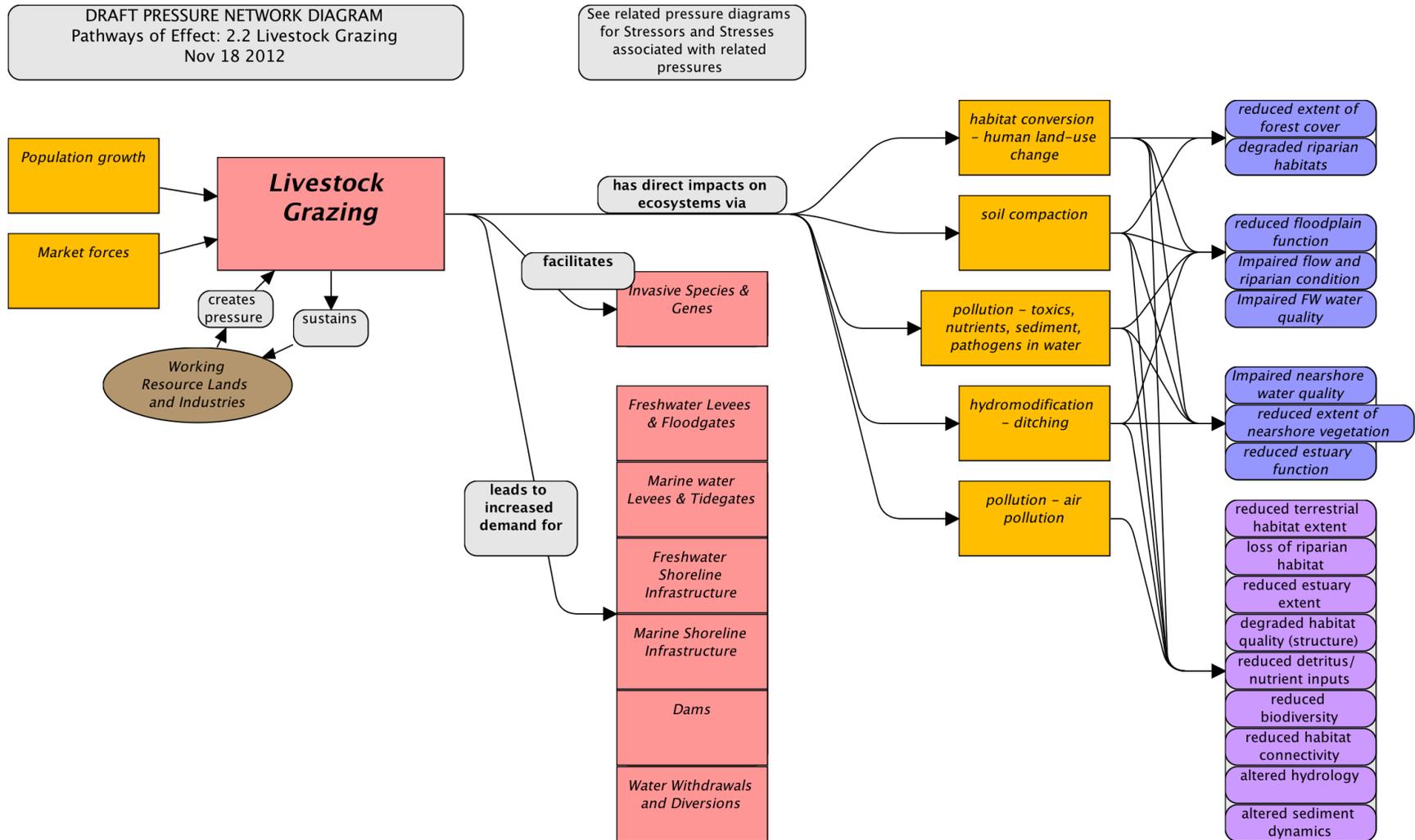
See related pressure diagrams for Stressors and Stresses associated with related pressures



**Figure 2.1 Agriculture Pressure Network Diagram**



**Figure 2.2 Livestock Grazing Pressure Network Diagram**



**Figure 2.3 Fin Fish Aquaculture Pressure Network Diagram**

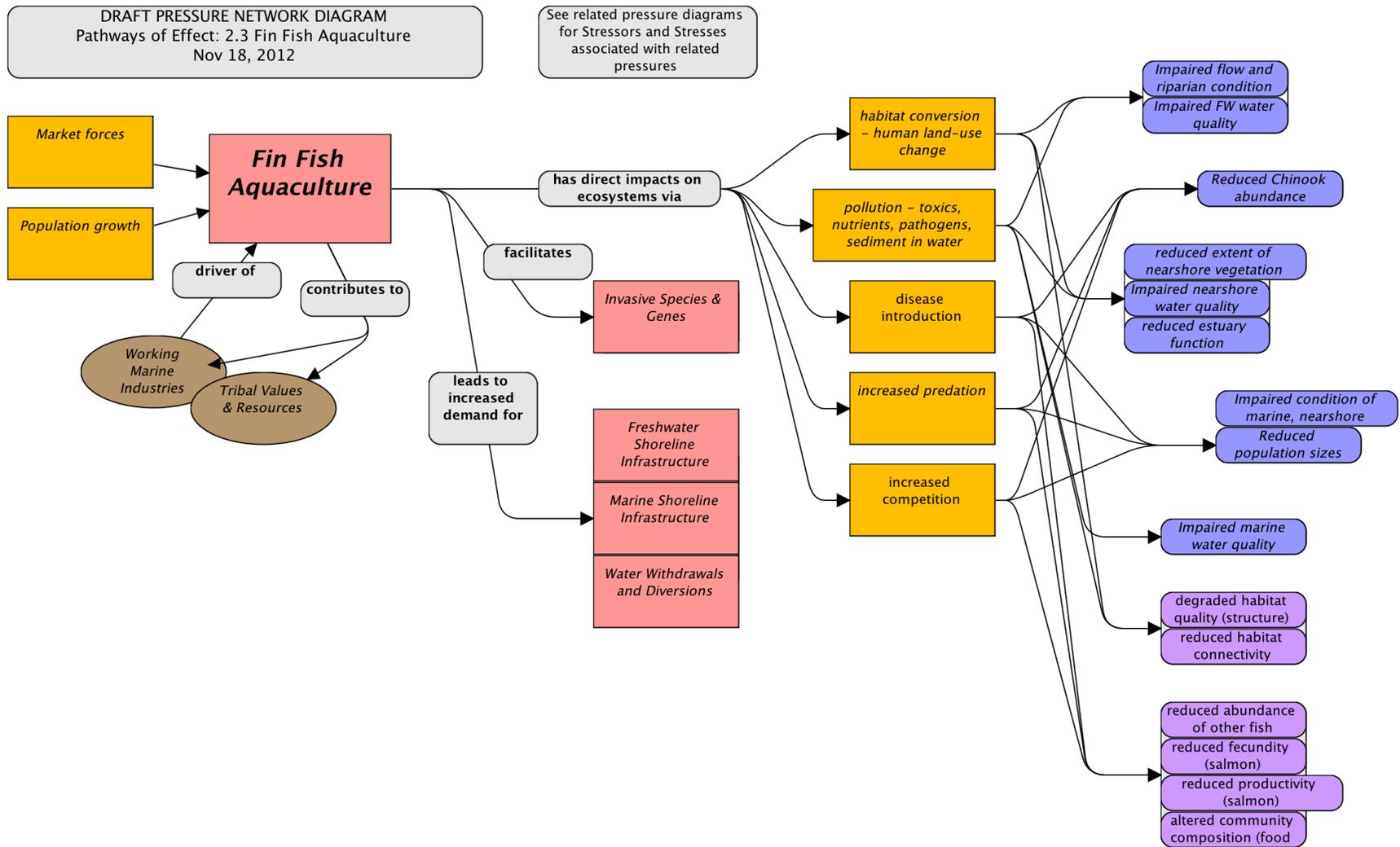
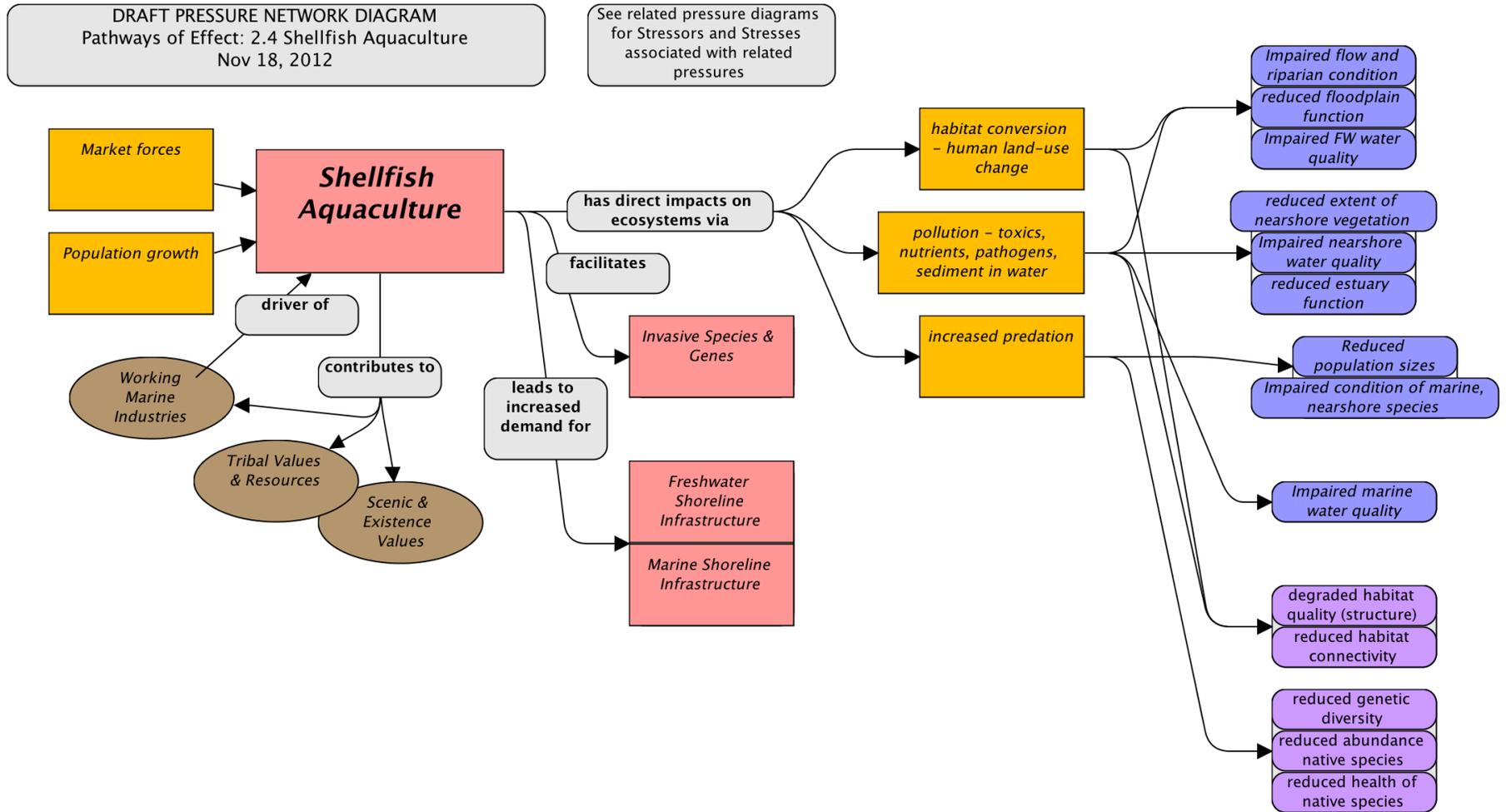
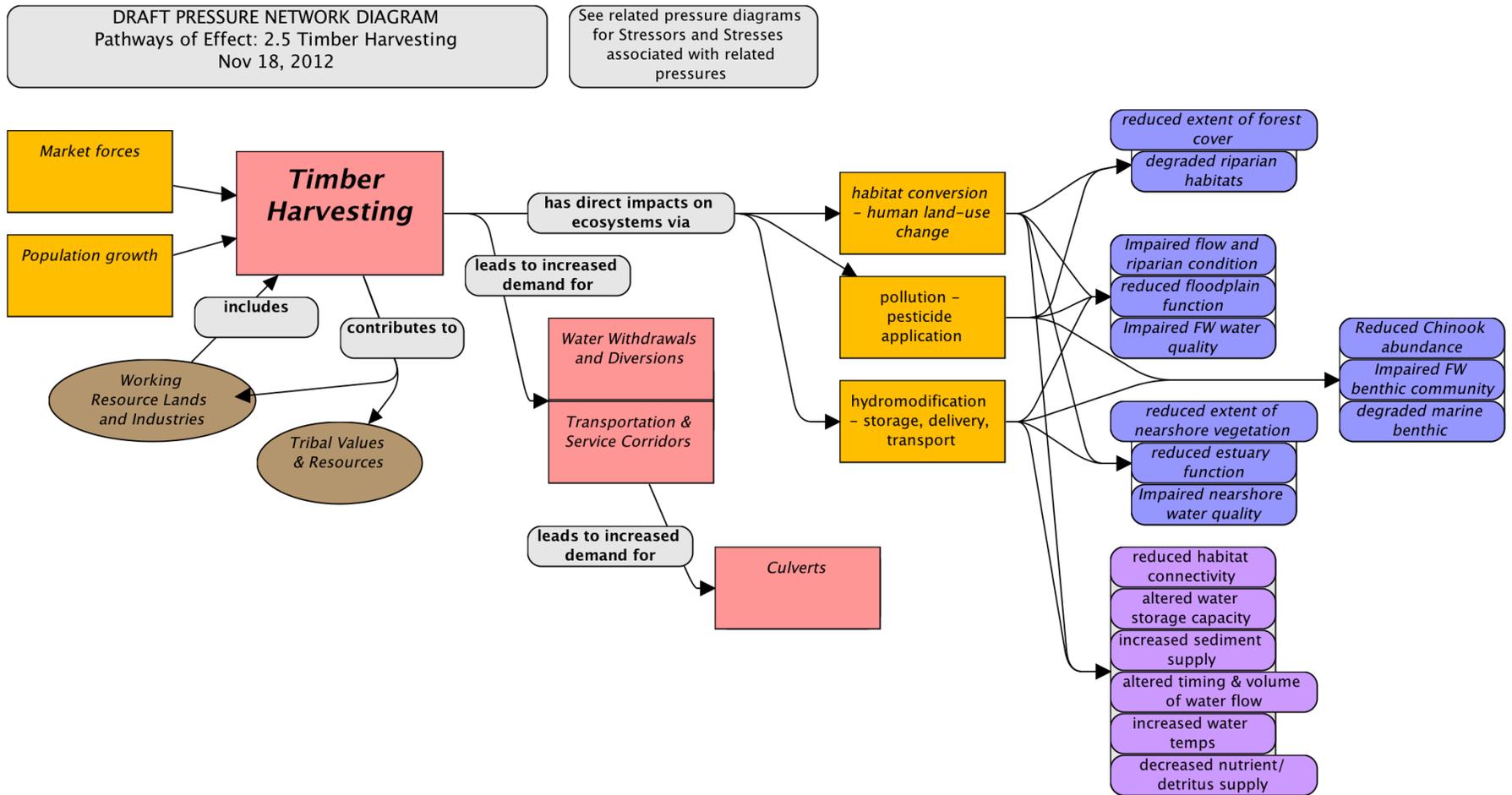


Figure 2.4 Shellfish Aquaculture Pressure Network Diagram



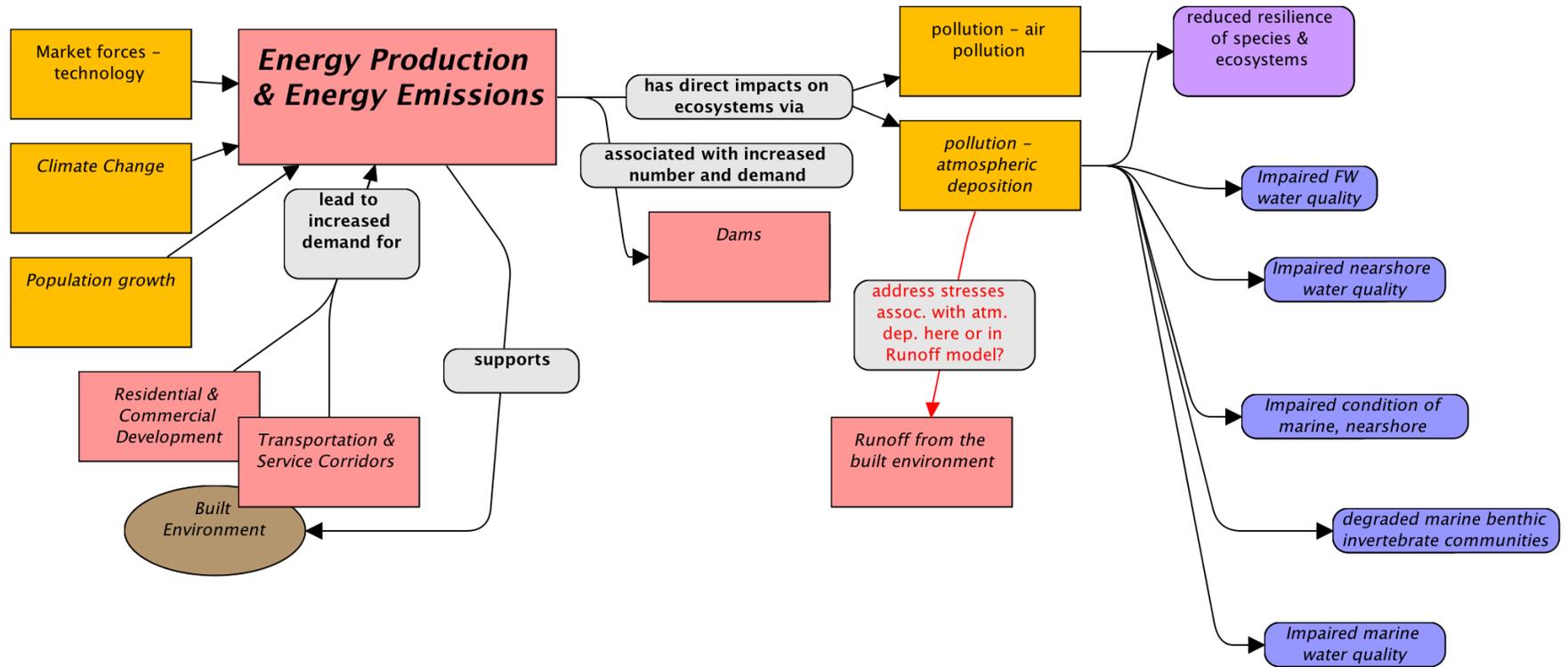
**Figure 2.5 Timber Harvesting Pressure Network Diagram**



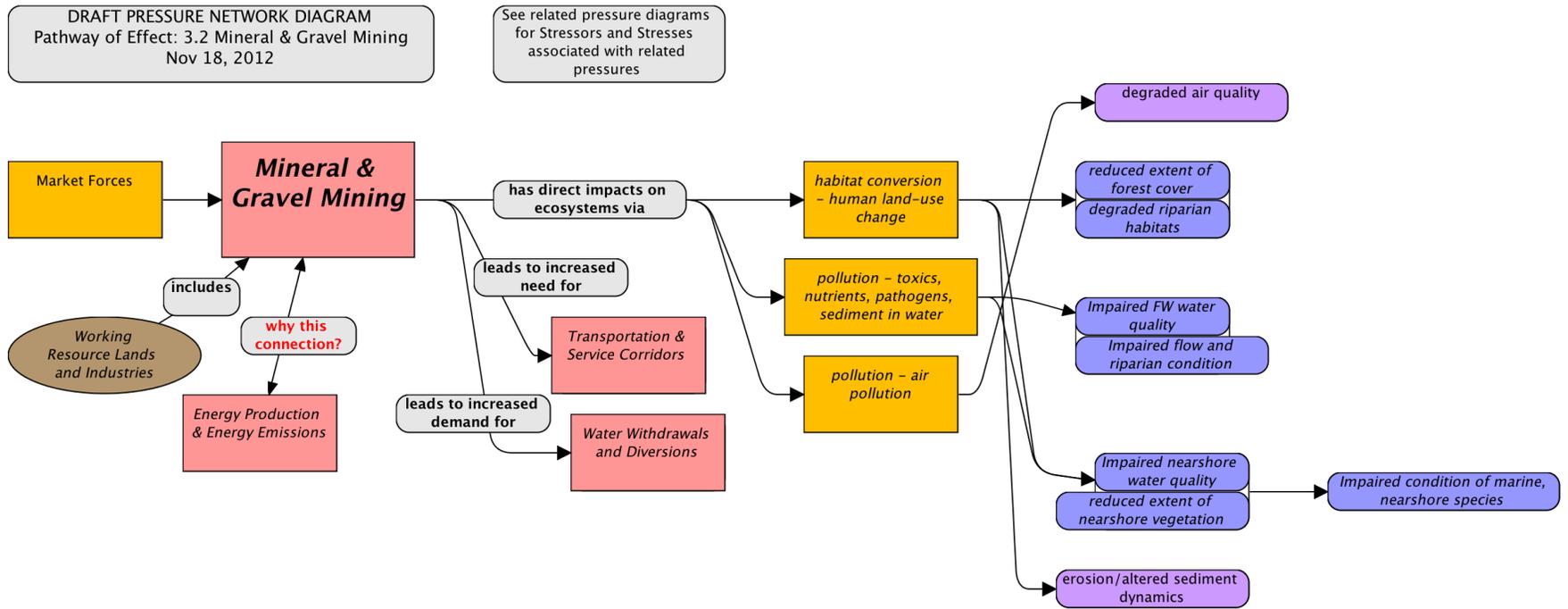
**Figure 3.1 Energy Production & Energy Emissions Pressure Network Diagram**

DRAFT PRESSURE NETWORK DIAGRAM  
 Pathways of Effect: 3.1 Energy Production & Energy Emissions  
 Nov 18, 2012

See related pressure diagrams  
 for Stressors and Stresses  
 associated with related  
 pressures



**Figure 3.2 Mineral & Gravel Mining Pressure Network Diagram**



**Figure 4.1 Transportation & Service Corridors Pressure Network Diagram**

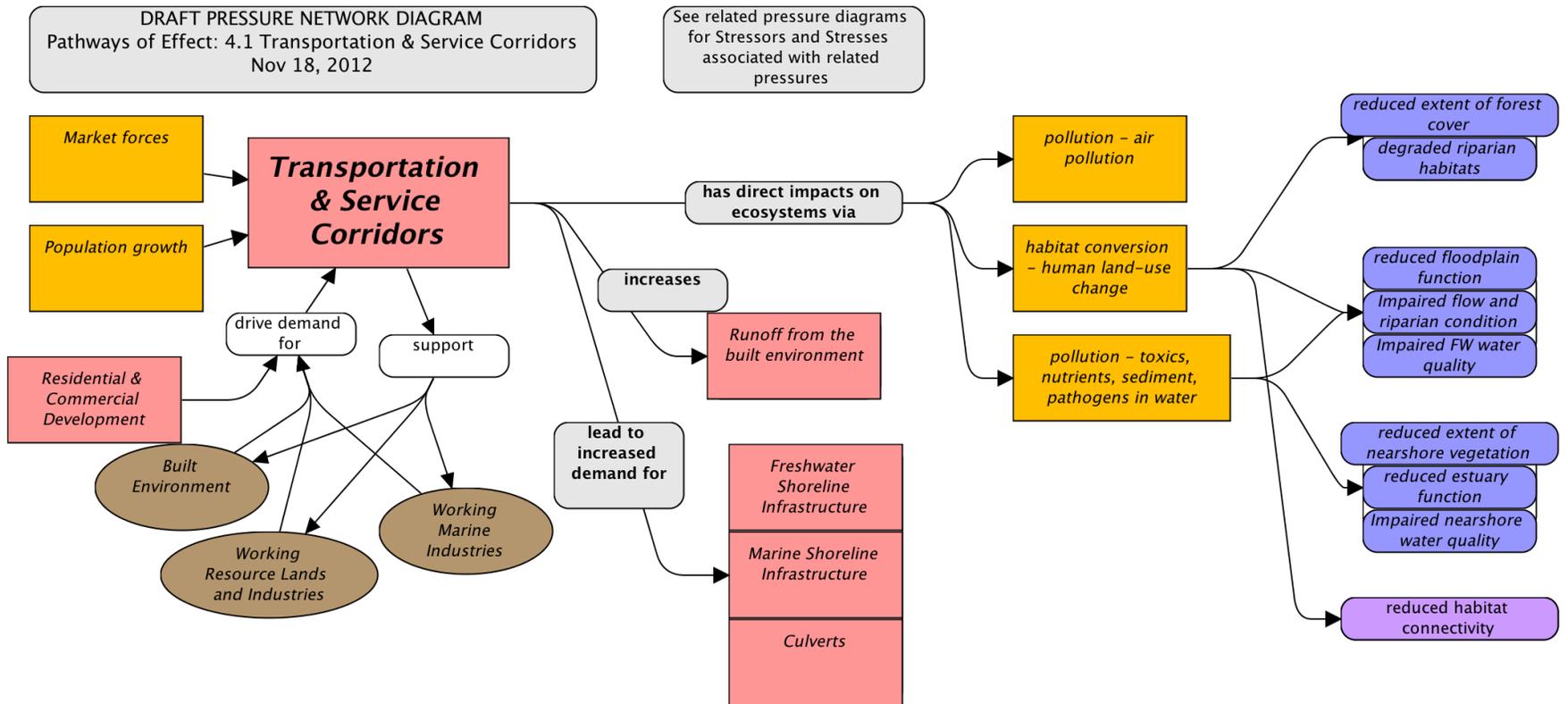
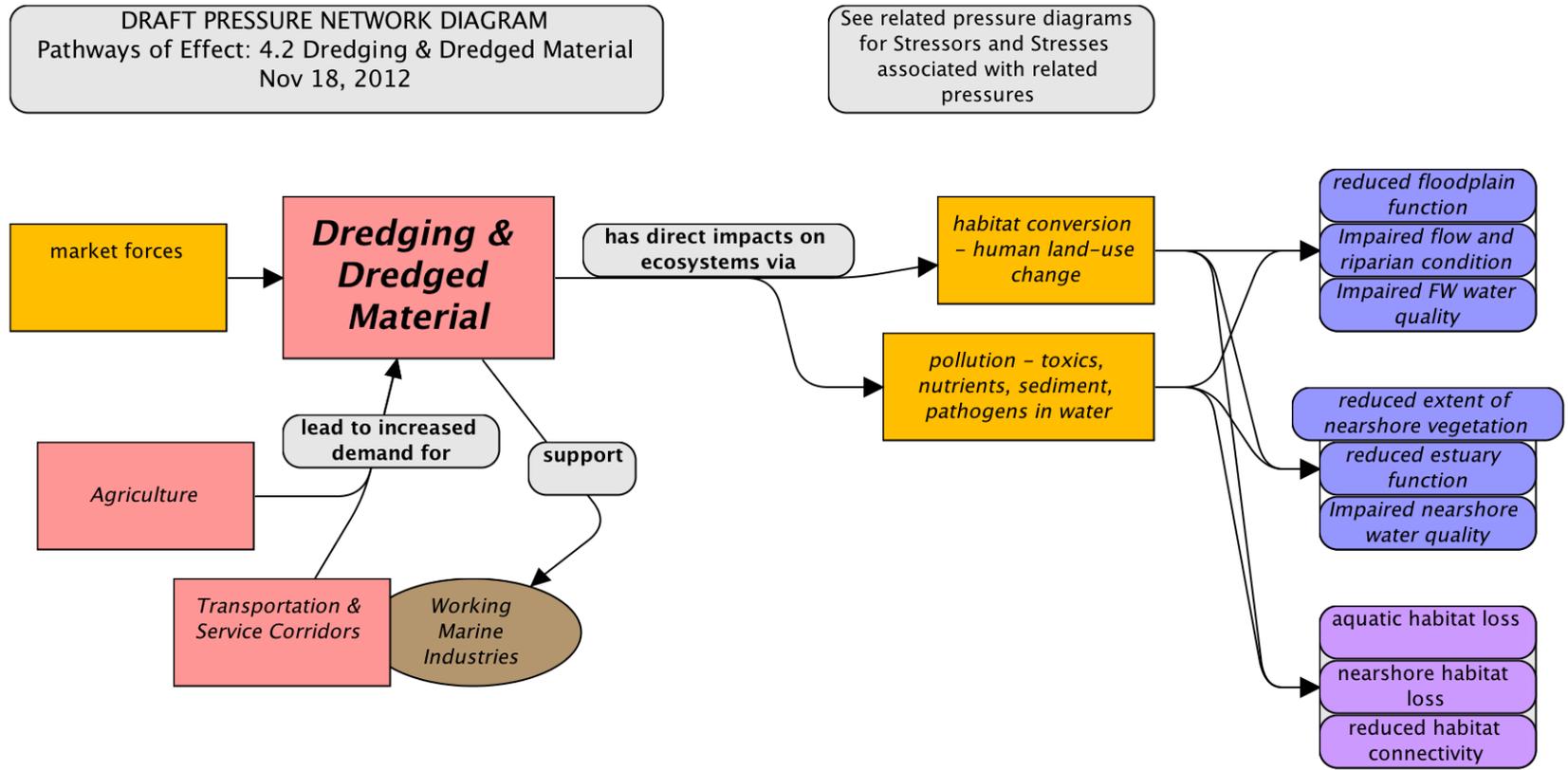
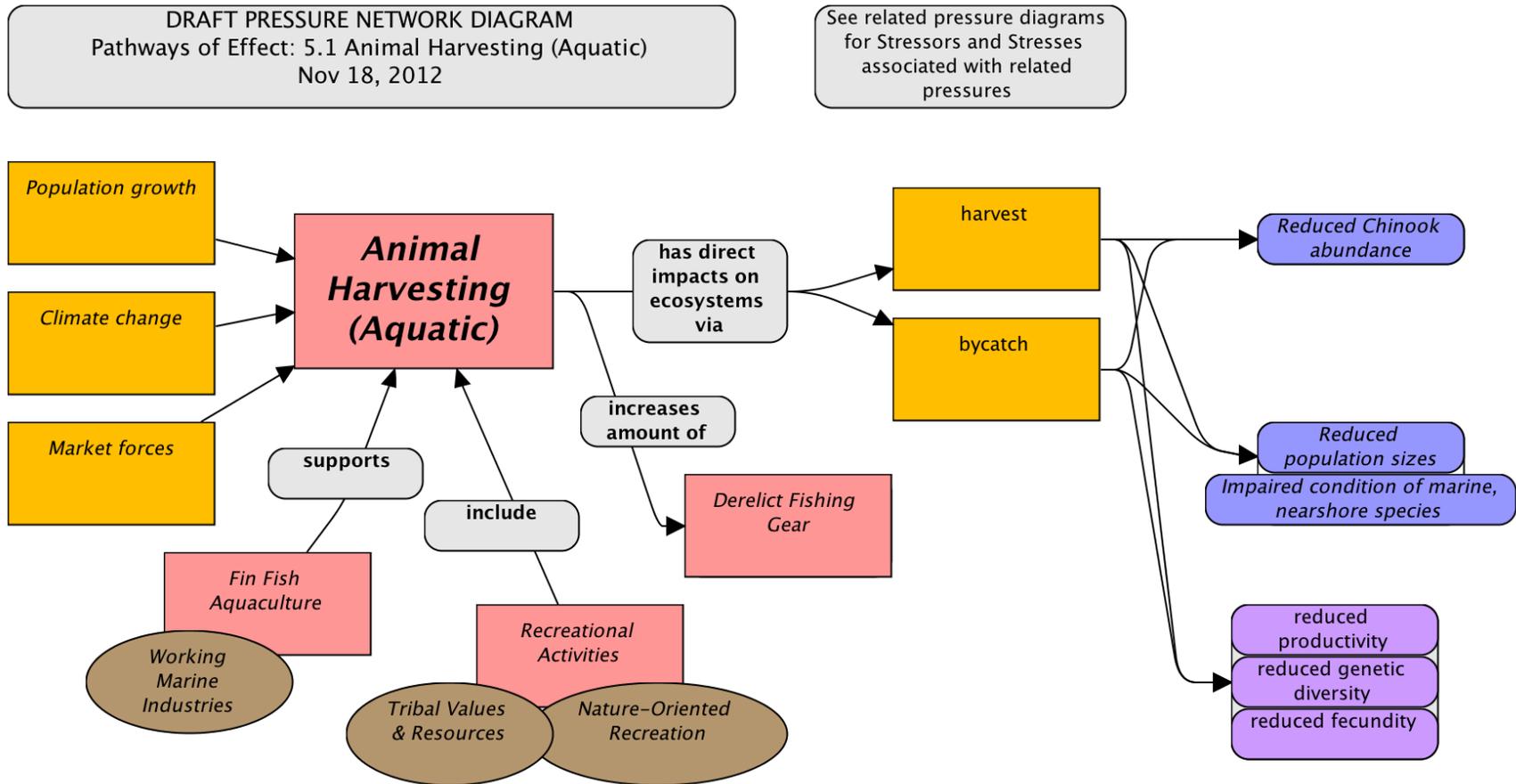


Figure 4.2 Dredging & Dredged Material Pressure Network Diagram



**Figure 5.1 Animal Harvesting (Aquatic) Pressure Network Diagram**



**Figure 5.2 Animal Harvesting (Terrestrial) Pressure Network Diagram**

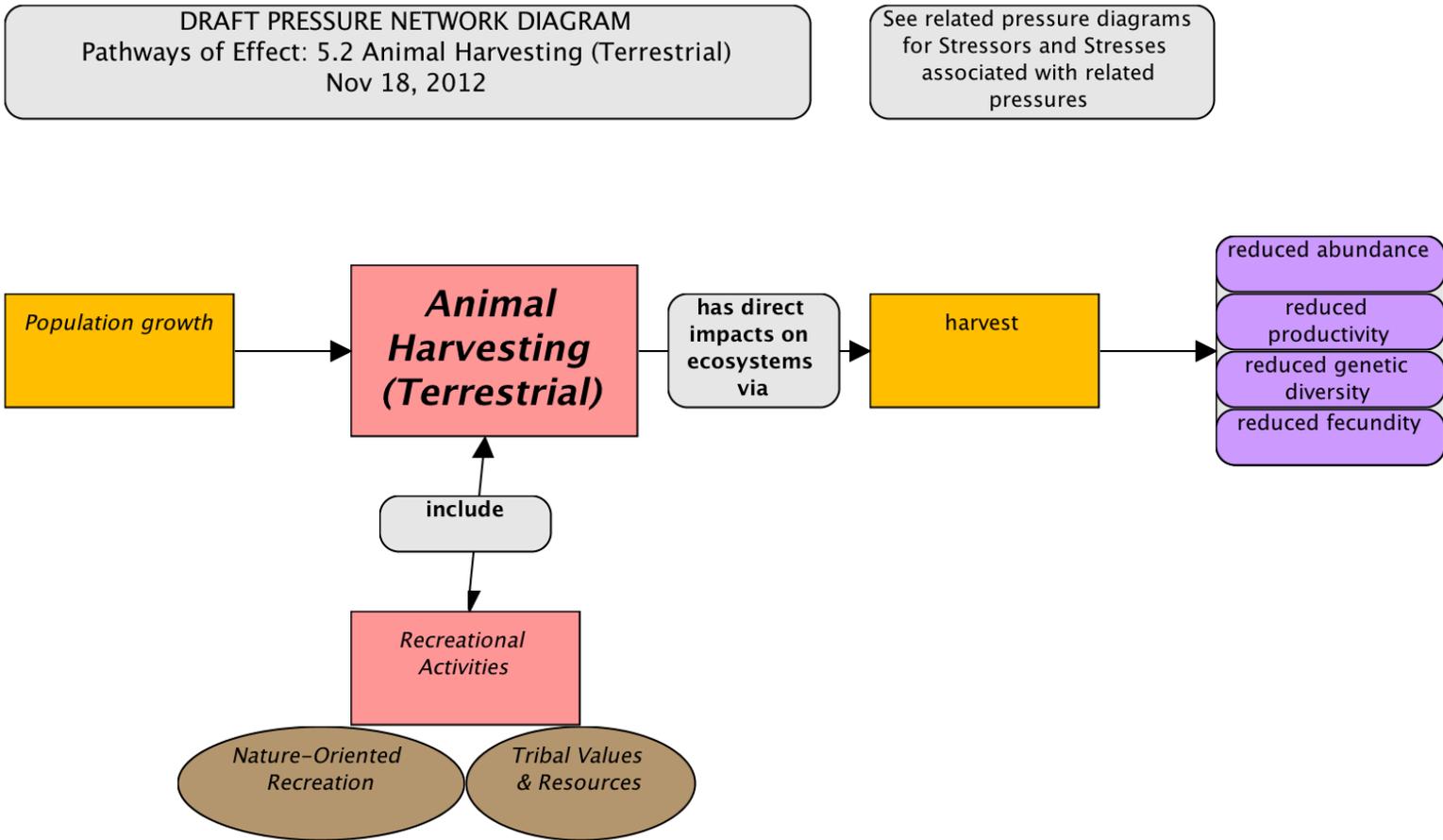


Figure 6.1 Recreational Activities Pressure Network Diagram

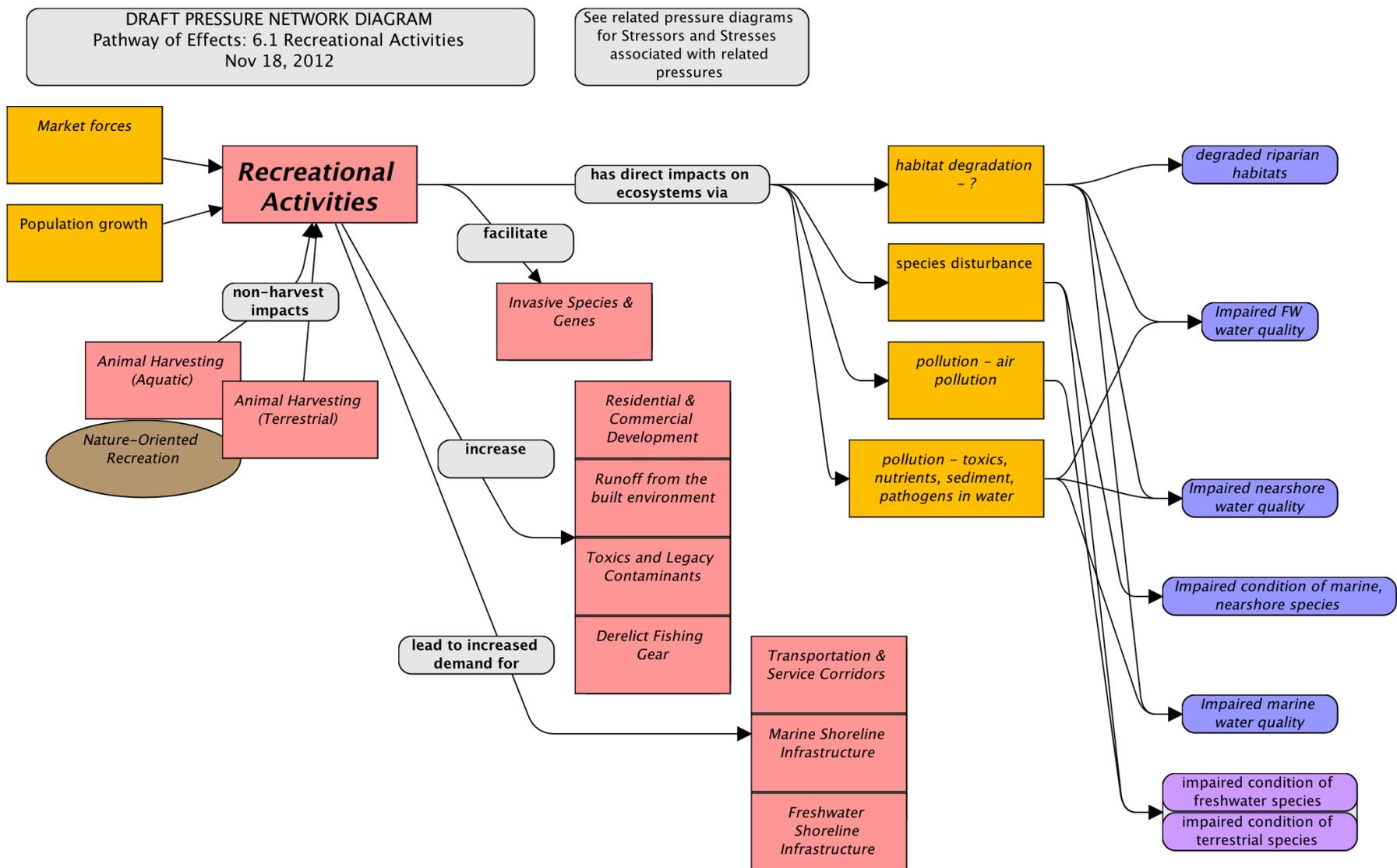
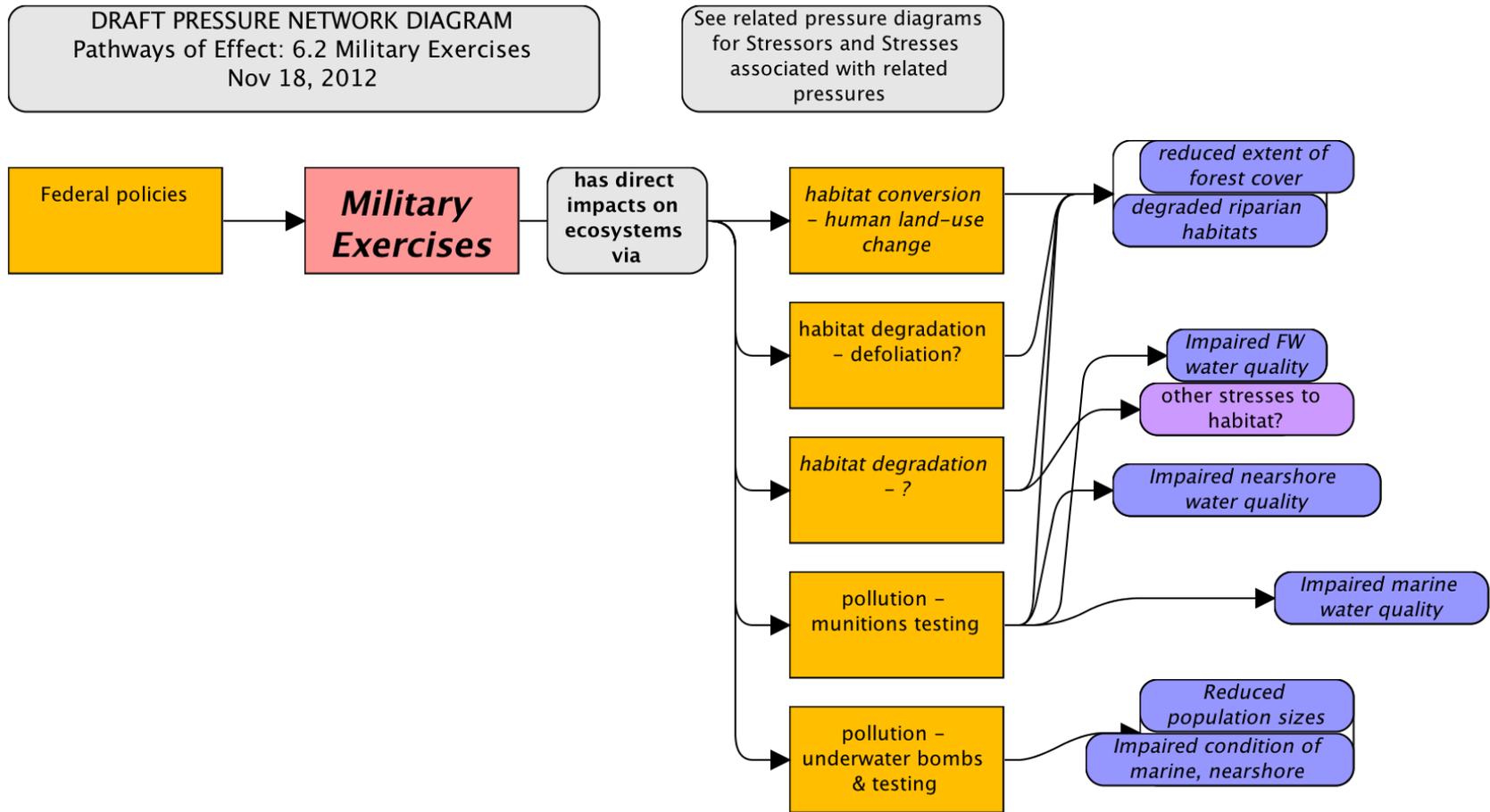


Figure 6.2 Military Exercises Pressure Network Diagram



**Figure 6.3 Derelict Fishing Gear Pressure Network Diagram**

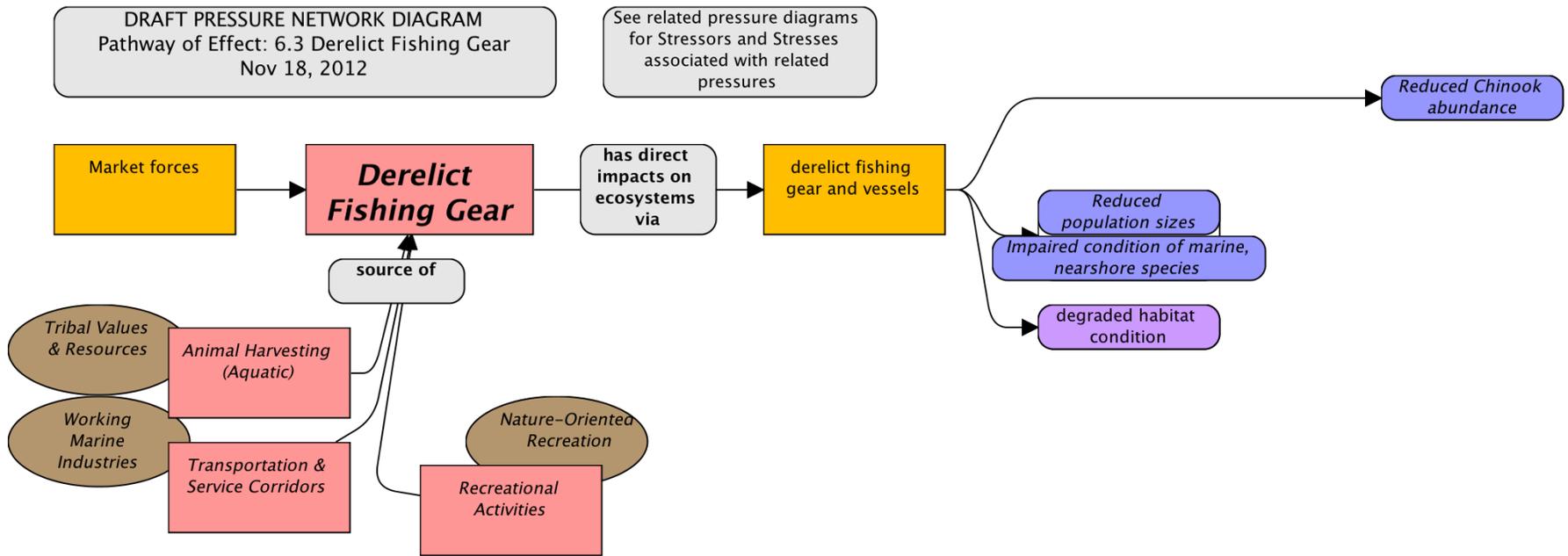


Figure 7.1 Dams Pressure Network Diagram

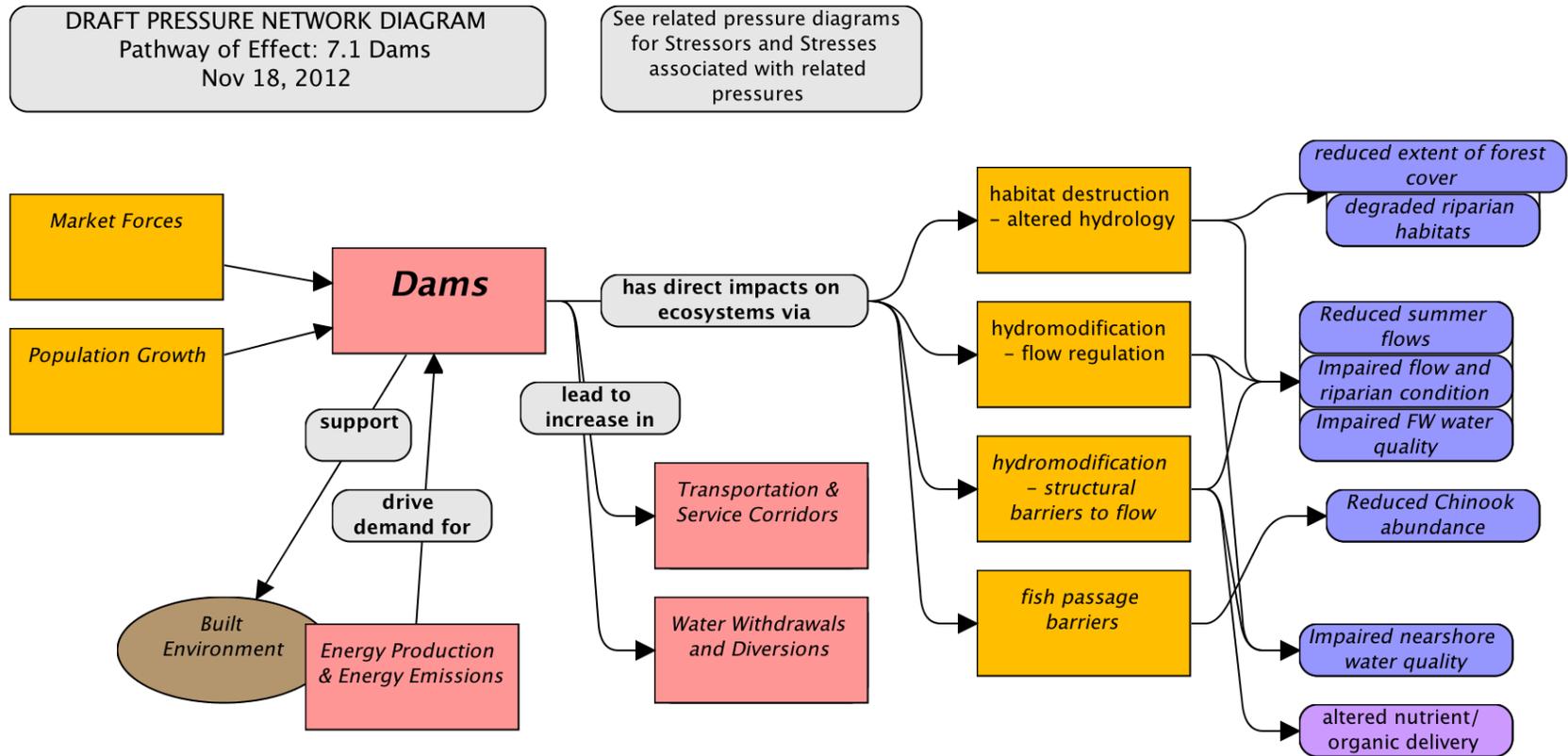


Figure 7.2 Culverts Pressure Network Diagram

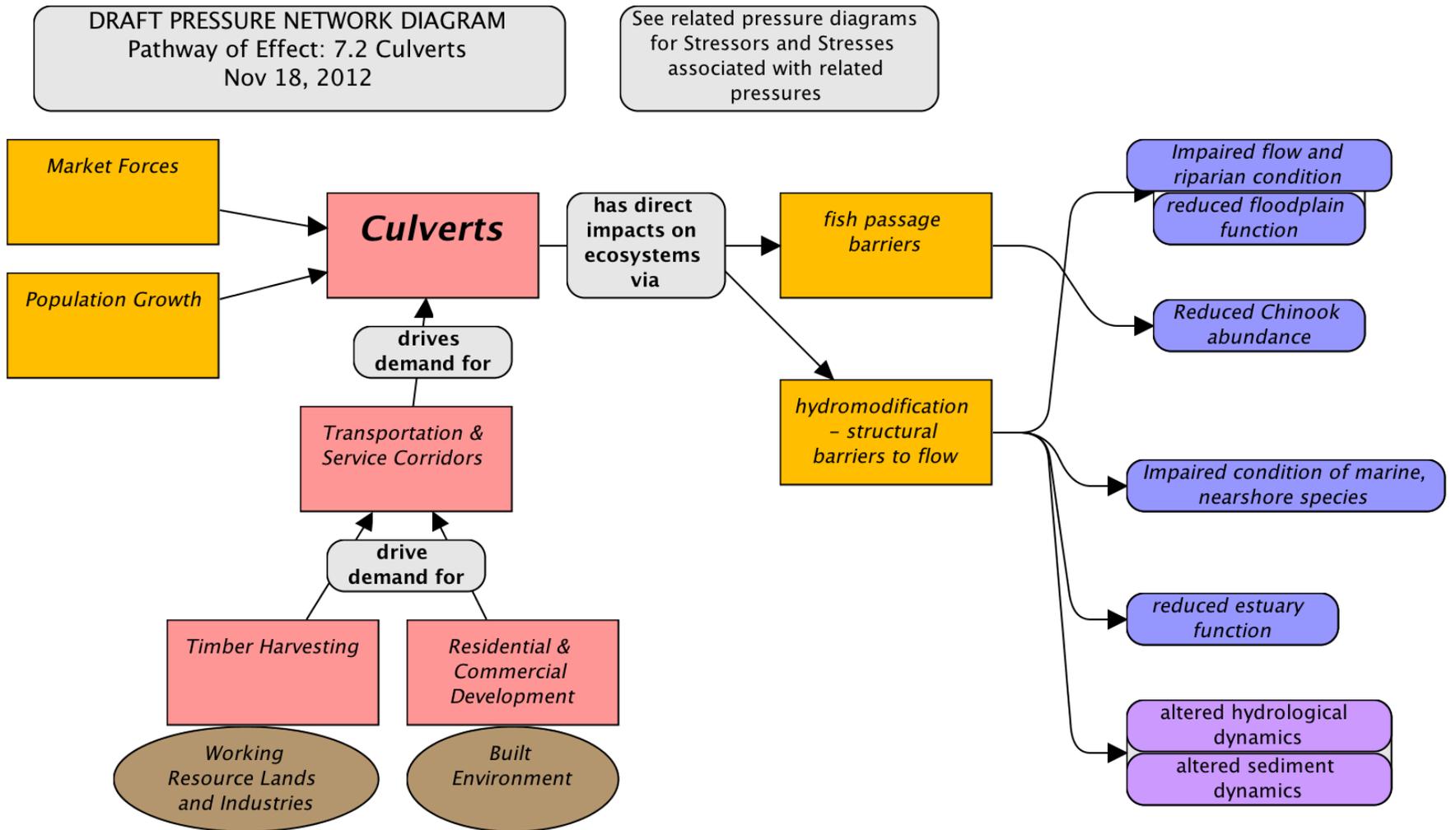


Figure 7.3 Freshwater Levees & Floodgates Pressure Network Diagram

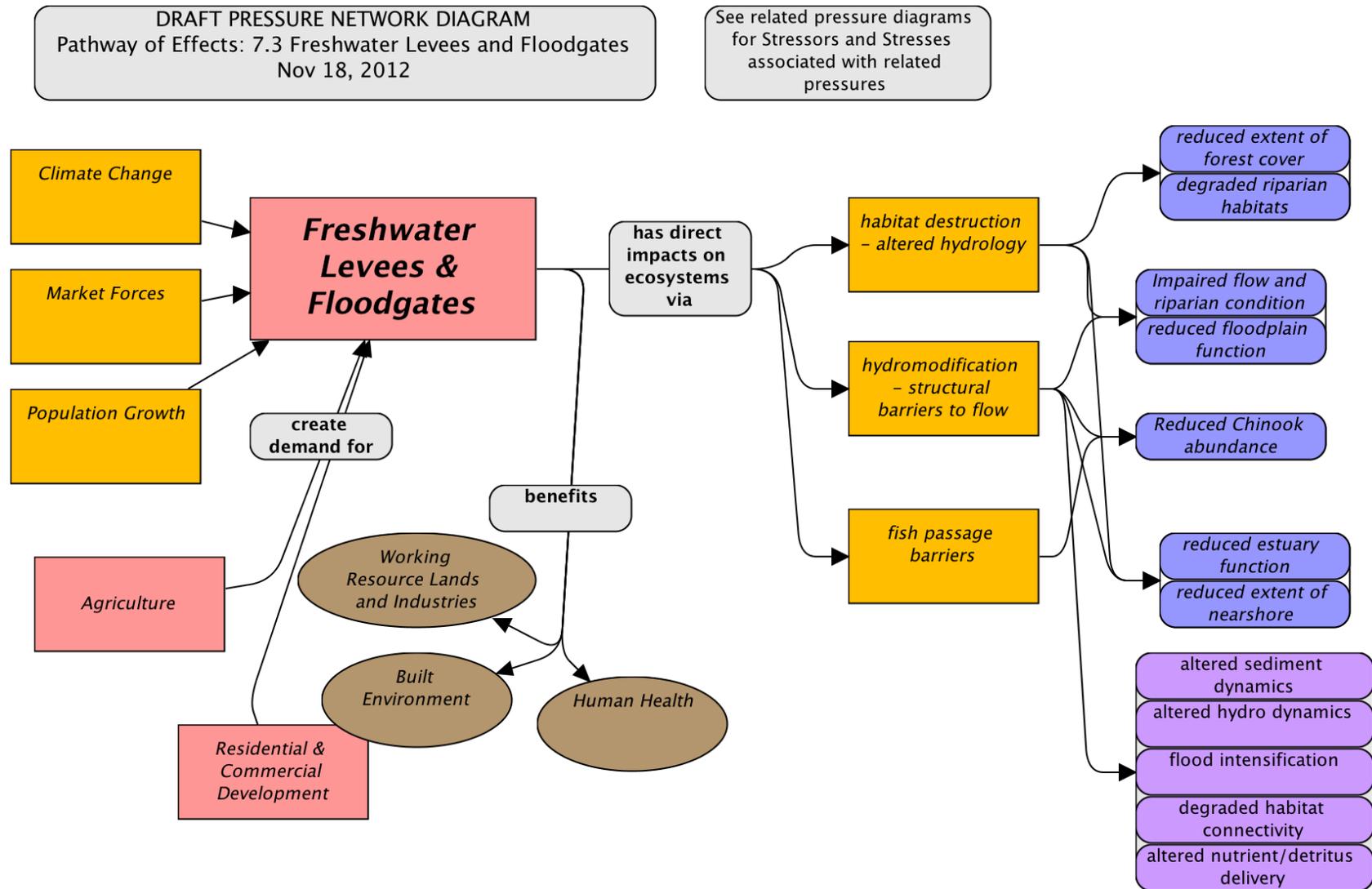
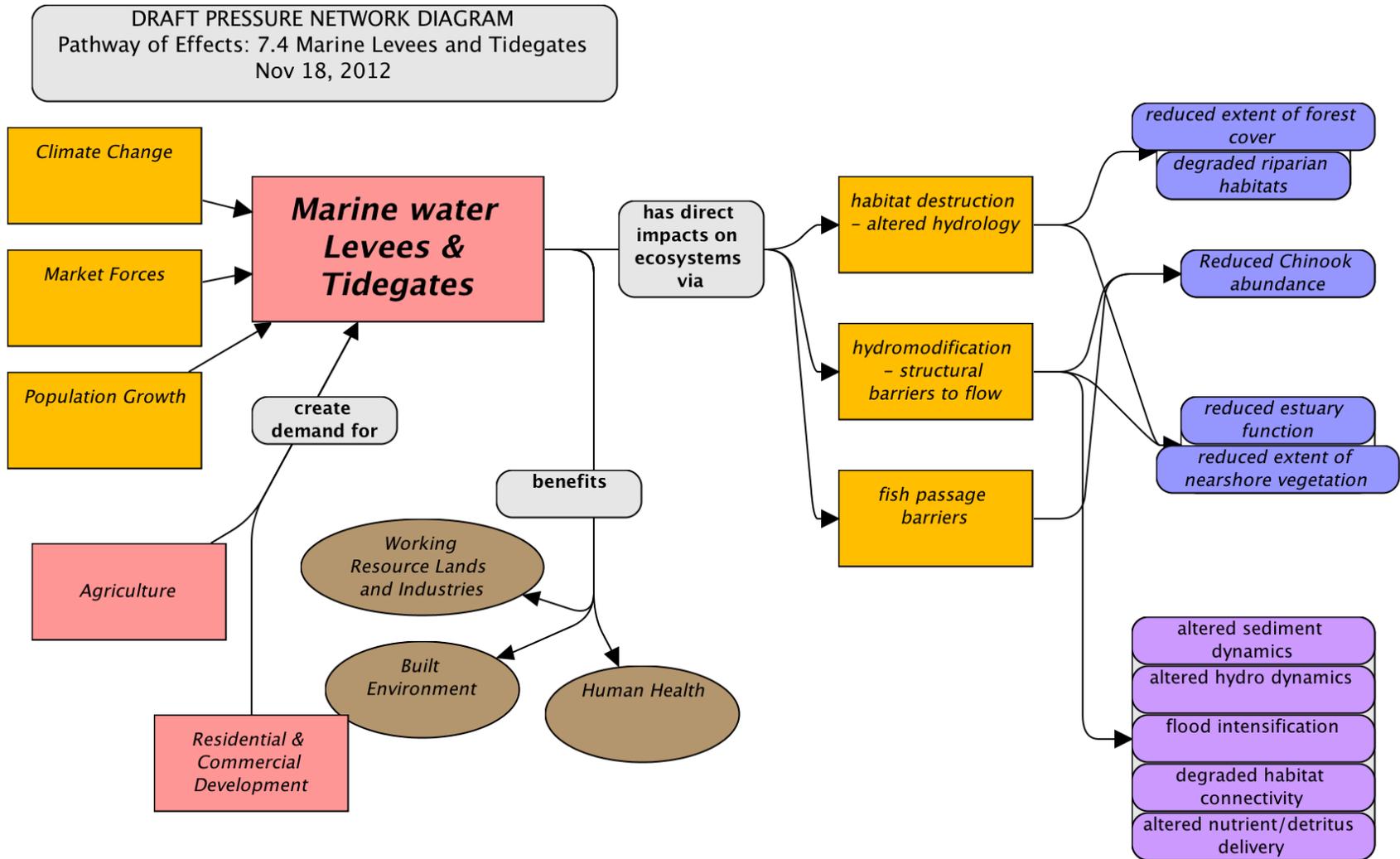
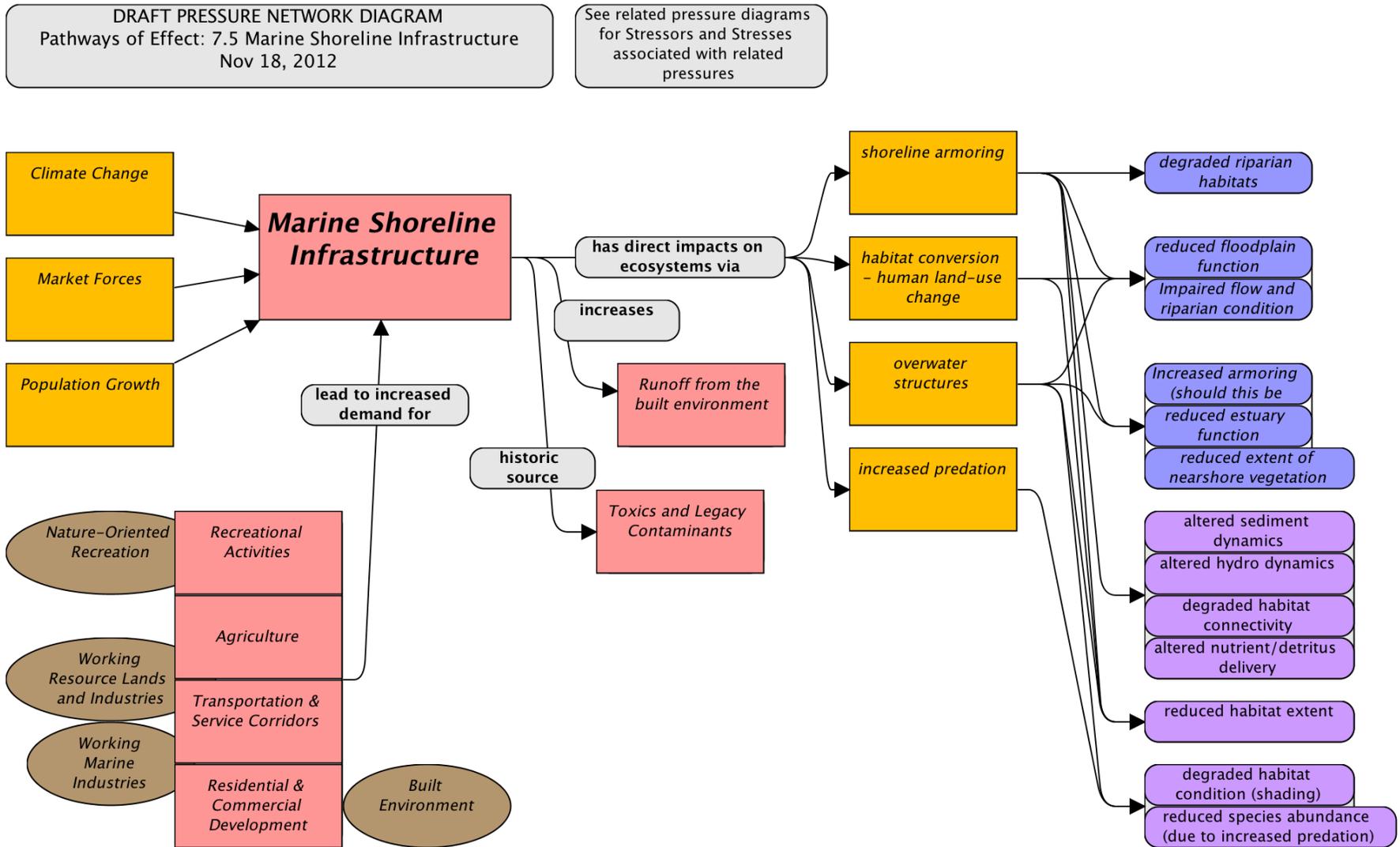


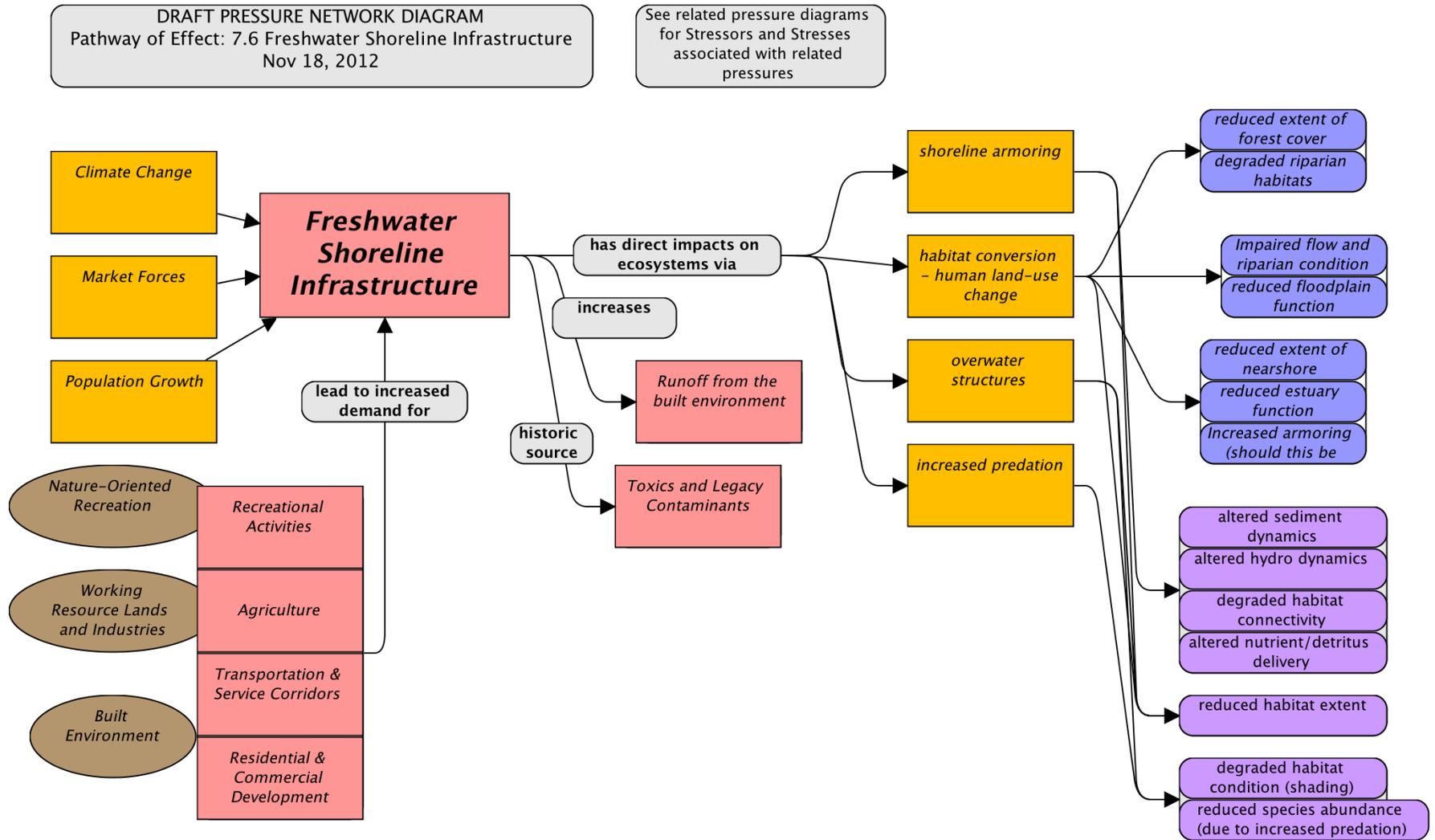
Figure 7.4 Marine Water Levels & Tidegates Pressure Network Diagram



**Figure 7.5 Marine Shoreline Infrastructure Pressure Network Diagram**



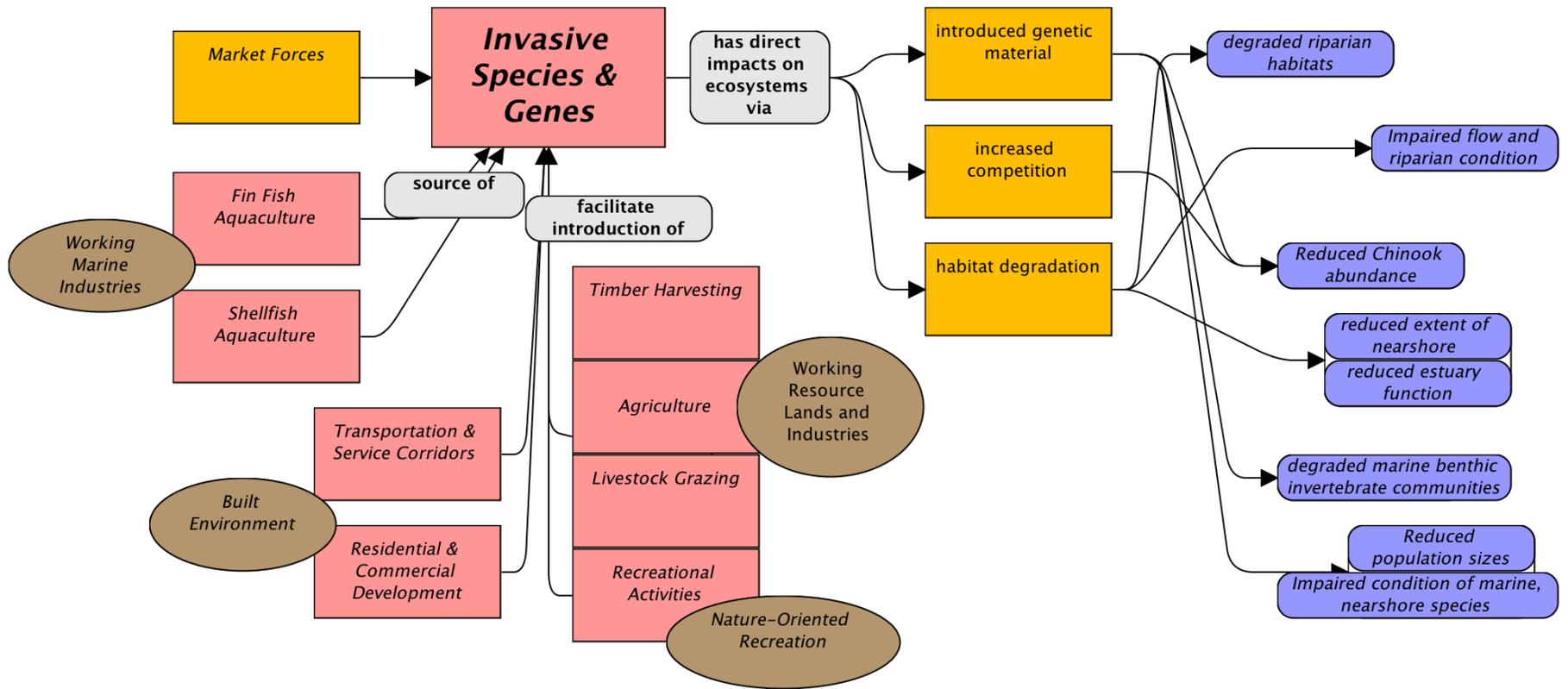
**Figure 7.6 Freshwater Shoreline Infrastructure Pressure Network Diagram**



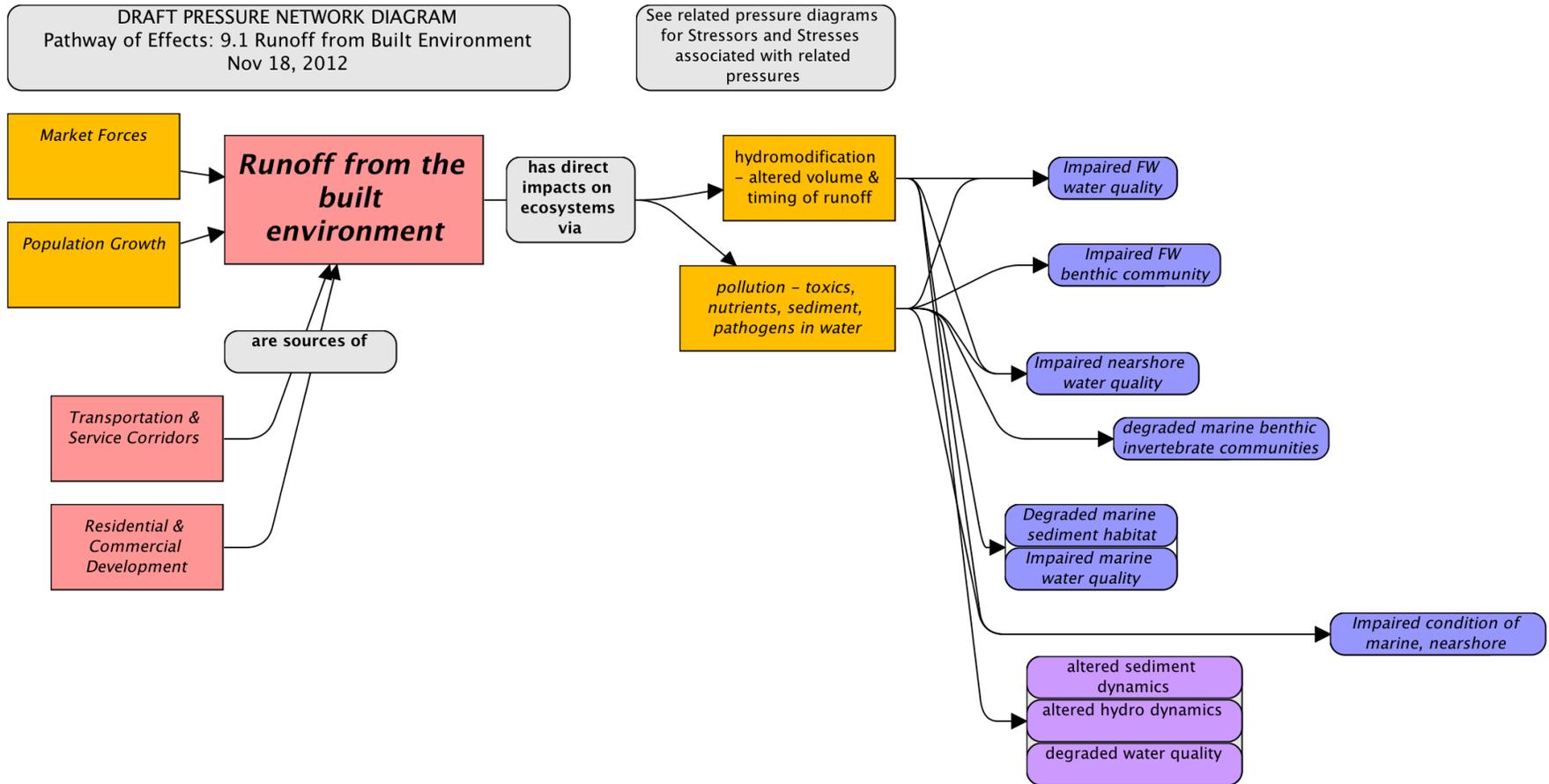
**Figure 8.1 Invasive Species Pressure Network Diagram**

DRAFT PRESSURE NETWORK DIAGRAM  
 Pathway of Effects: 8.1 Invasive Species & Genes  
 Nov 18, 2012

See related pressure diagrams  
 for Stressors and Stresses  
 associated with related  
 pressures



**Figure 9.1 Runoff from the Built Environment Pressure Network Diagram**



**Figure 9.2 Industrial, Domestic & Municipal Wastewater Pressure Network Diagram**

DRAFT PRESSURE NETWORK DIAGRAM  
 Pathway of Effects: 9.2 Industrial, Domestic & Municipal Wastewater  
 Nov 18, 2012

See related pressure diagrams  
 for Stressors and Stresses  
 associated with related  
 pressures

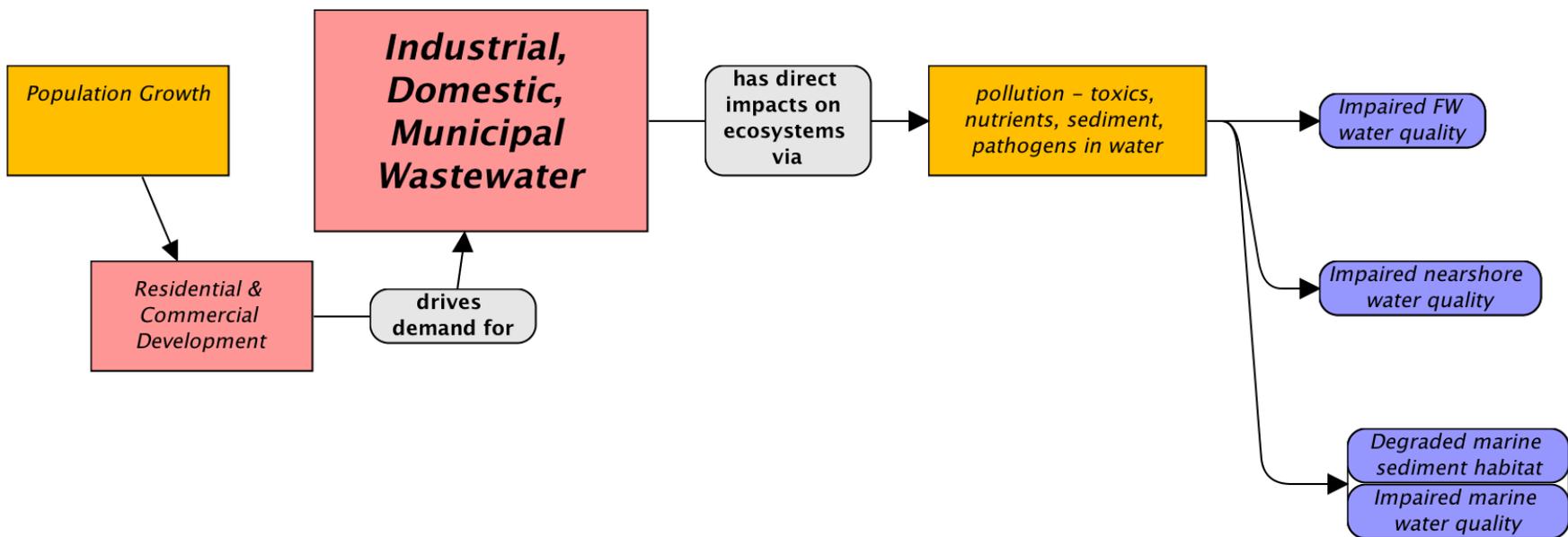


Figure 9.3 Onsite Sewage Systems Pressure Network Diagram

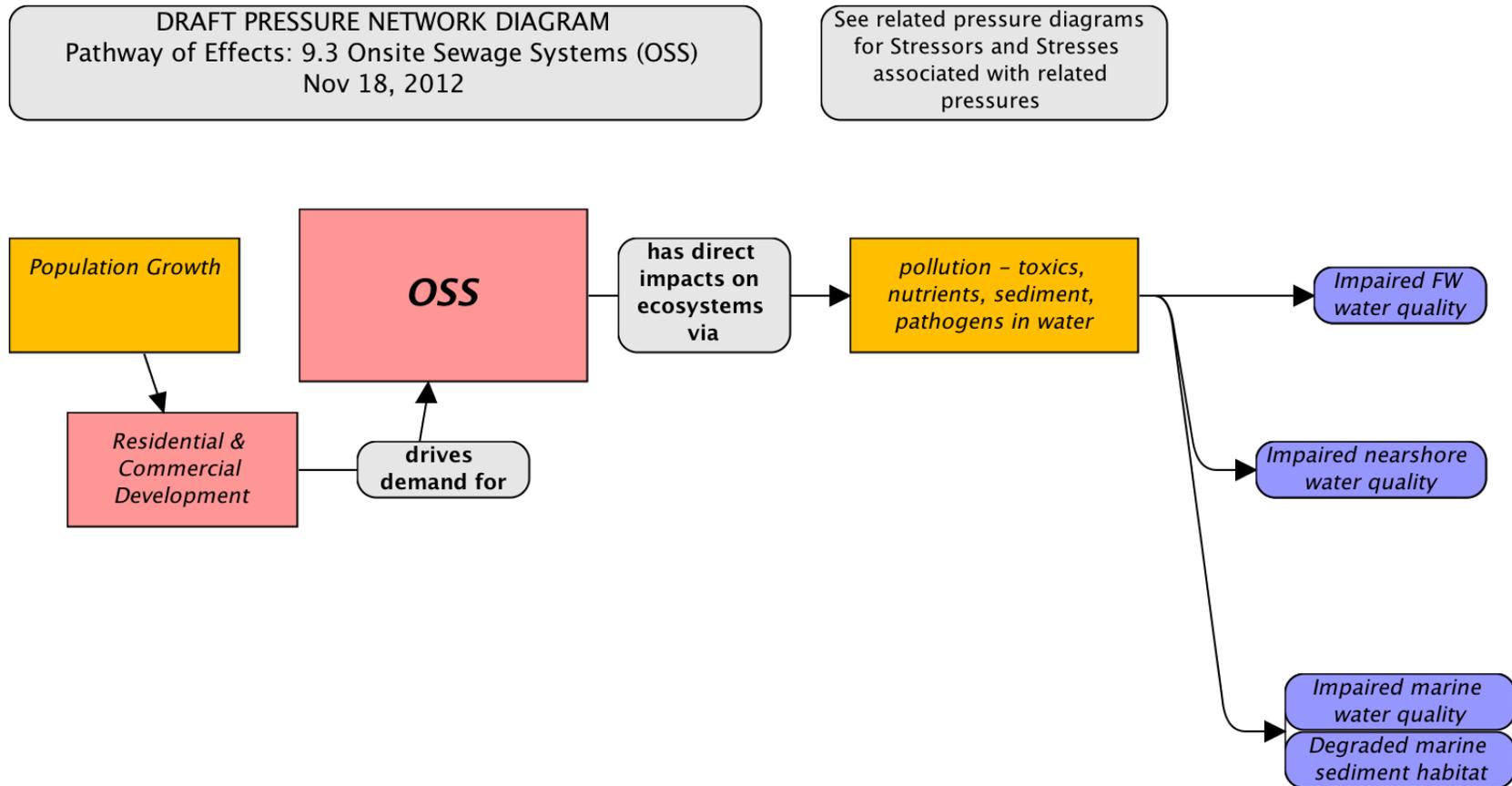
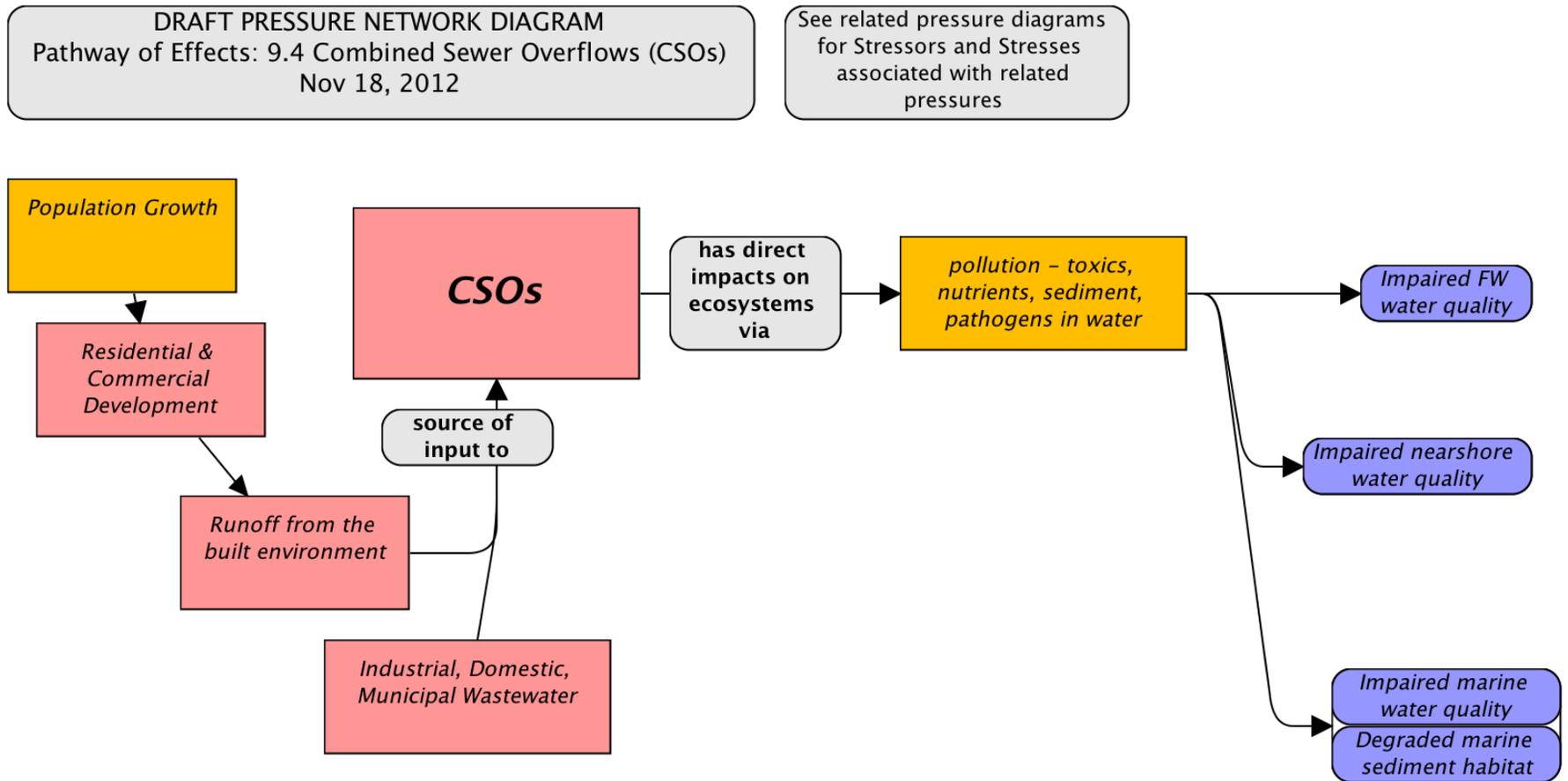


Figure 9.4 Combined Sewer Overflows Pressure Network Diagram



**Figure 9.5 Toxics & Legacy Contaminants Pressure Network Diagram**

DRAFT PRESSURE NETWORK DIAGRAM  
 Pathways of Effects: 9.5 Toxics & Legacy Contaminants  
 Nov 18, 2012

See related pressure diagrams  
 for Stressors and Stresses  
 associated with related  
 pressures

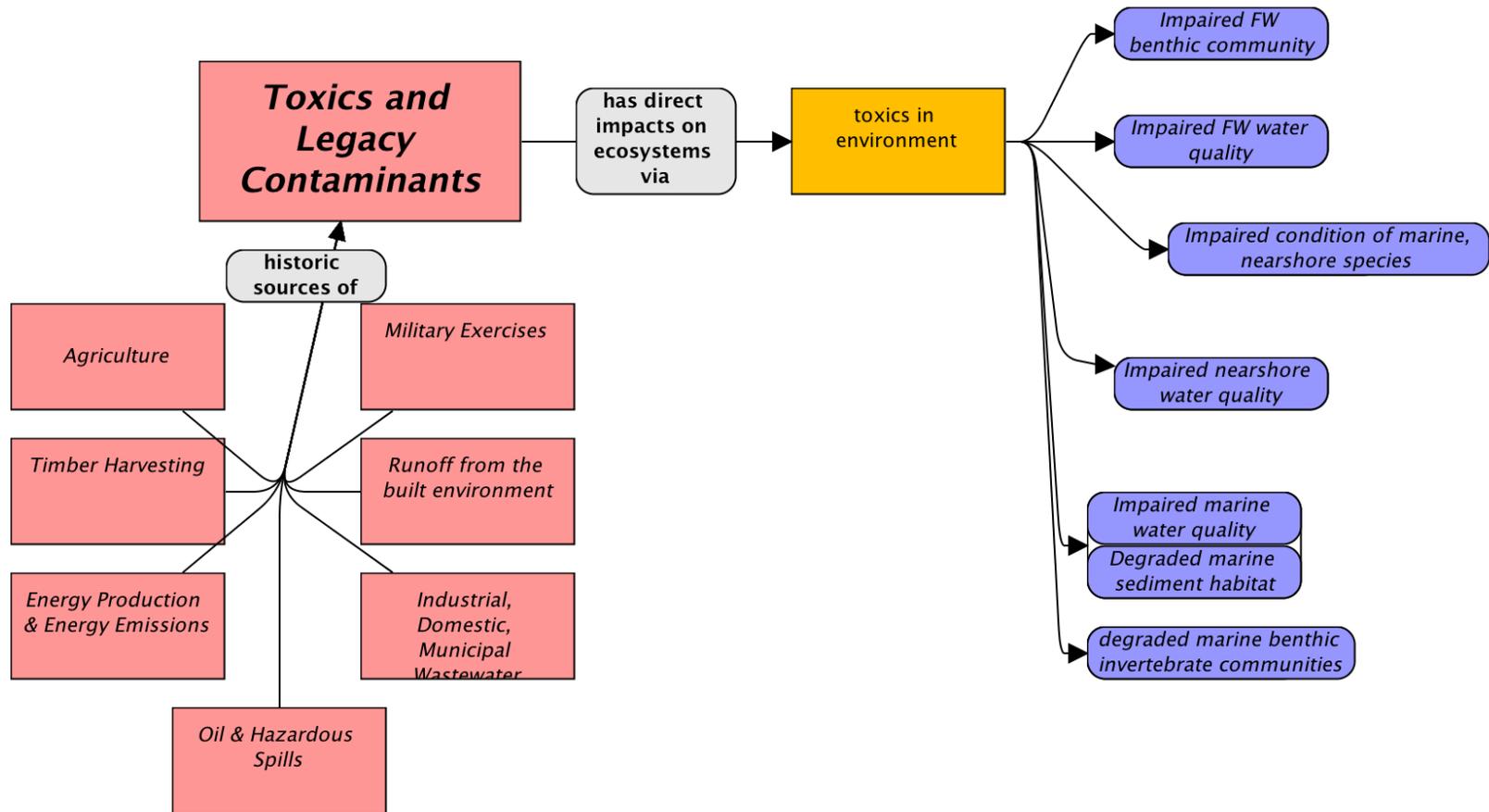
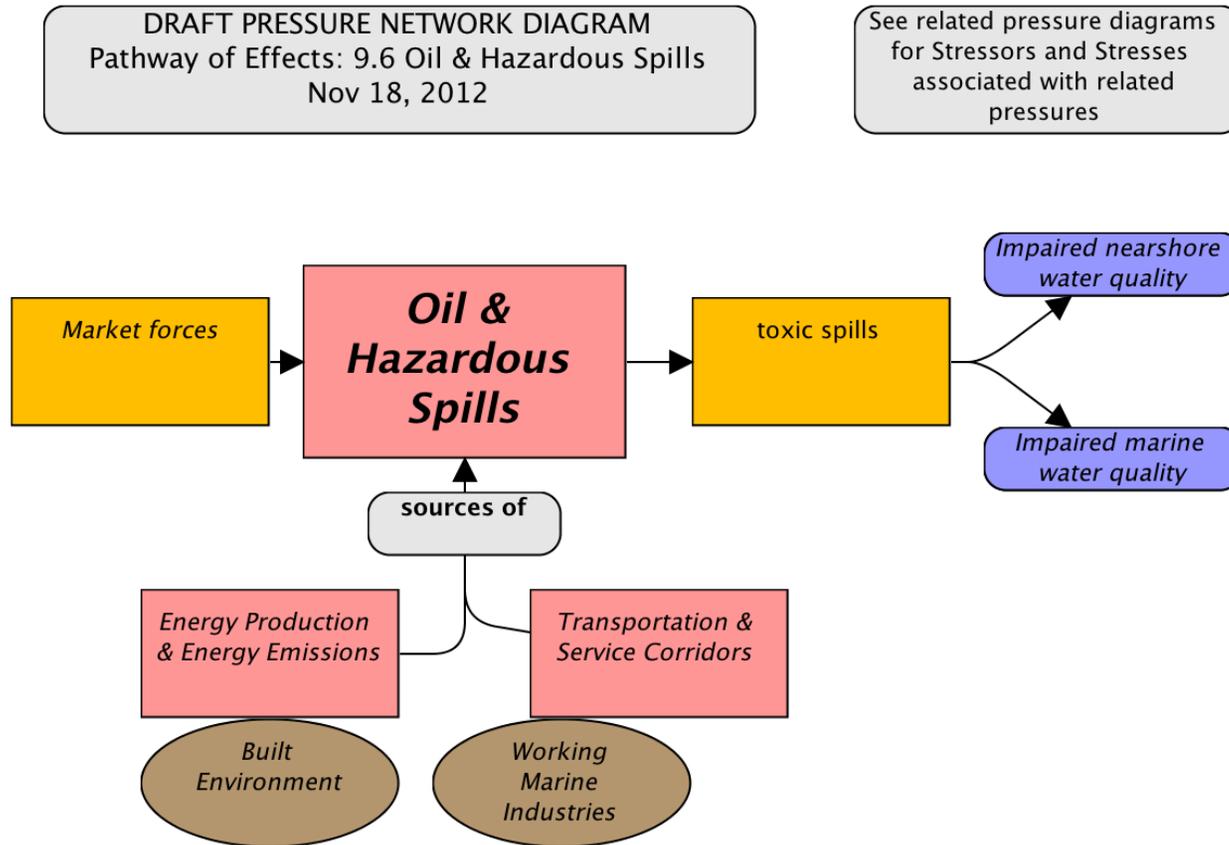


Figure 9.6 Oil & Hazardous Spills Pressure Network Diagram



**Figure 10.1 Water Withdrawals & Diversions Pressure Network Diagram**

