



**A CONSIDERATION OF THE HARBOR PORPOISE  
AS A SENTINEL SPECIES FOR THE SALISH SEA**

*Research by Pacific Biodiversity Institute*

## THE SALISH SEA: A ONCE THRIVING RESOURCE ON THE REBOUND

Prior to the settlement era, the Salish Sea teemed with an enormous diversity of life. Native American communities and the earliest settlers benefited from the abundance of valuable resources. In less than a century, the rapid growth of the settlement communities located around the Puget Sound depleted many of the once abundant resources and seriously degraded the marine environment. A wide variety of pollutants were introduced, significantly altering the habitats critical to the life of many marine organisms.

The health of the Salish Sea ecosystem had diminished by the 1970s to the point that many components of the ecosystem were in critical condition. Several species were virtually eliminated.

After the 1970s, public recognition of the degraded state of this ecosystem grew and concerned citizens launched efforts to restore the health of this body of water. In the United States, non-profit organizations, such as People for the Puget Sound, and governmental agencies, including Puget Sound Partnership, Washington Department of Fish and Wildlife, Washington Department of Ecology, the Environmental Protection Agency and the National Oceanic and Atmospheric Administration, became active in a variety of efforts to restore ecosystem components, protect habitat, reduce pollution and regulate exploitation of resources.

Today, we are beginning to see signs that these efforts are starting to have a positive effect, but the health of the Puget Sound ecosystem is still greatly diminished from its pre-settlement state.

Washington State's Puget Sound ecosystem is arguably the state's greatest asset. Efforts to restore the health of this ecosystem and monitor this progress are essential to Washington state's future. We won't be able to fully realize the benefits provided to our society by this unique marine ecosystem unless we restore it.



*Map of the Salish Sea and Surrounding Basin.*  
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## MONITORING A SENTINEL SPECIES IS A PRACTICAL, COST-EFFICIENT SOLUTION

Monitoring the health of the Puget Sound ecosystem is a priority for the current conservation, restoration and clean-up efforts directed at this ecosystem. Without objective monitoring, it will be impossible to gauge whether efforts to restore this high-value ecosystem have been effective.

Many methods of monitoring the health of marine ecosystems are possible. The Puget Sound Partnership has suggested 61 indicators for monitoring the health of the Puget Sound (O'Neill et al 2008).

The expense of monitoring every different component of a complex ecosystem is out of the range of public agencies that are coping with extensive budget cuts. Fortunately, the complex interaction networks that comprise marine ecosystems are organized in such a way that a few "sentinel species" can be used as indicators of the health of the entire ecosystem.

From a practical perspective, having a few reliable species that are relatively easy to monitor helps multiple agencies and organizations work together and share data. It is also easier for citizen science efforts to help fill gaps in the research on ecosystem conditions.

Pacific Biodiversity Institute began studying the harbor porpoise in 2007. We have concluded that the Inland Waters Harbor Porpoise meets the characteristics of an ideal sentinel species for the Salish Sea. We are working to see that efforts to monitor this species are furthered and expanded upon.

## CHARACTERISTICS OF THE HARBOR PORPOISE

***Its diet, range, status and life span all add up to make the harbor porpoise an ideal sentinel species for the Salish Sea***

***\* It's a marine mammal.***

Numerous scientists have already concluded that marine mammals, in general, are effective sentinel species for monitoring marine ecosystem health.

***\* The harbor porpoise's diet is a measure of health.***

In a marine environment, the health and size of the forage fish populations are critical indicators of ecosystem health. Species near the apex of complex food webs can illustrate the overall health of the entire ecosystem.

The harbor porpoise feeds on small forage fish such as herring, smelt, sand lance and others. Consequently, the balance and health of the Puget Sound ecosystem may be measured by the foraging success of the harbor porpoise.

***\* It's a sensitive creature.***

The population of an ideal sentinel species will fluctuate with a changing environment. Such a population goes up when the environmental conditions improve and goes down when those conditions deteriorate.

The harbor porpoise shows this trend, having declined significantly from its pre-settlement abundance, but it now may be making a rebound.

***\* Harbor porpoises don't leave the Salish Sea.***

An ideal sentinel species will spend the vast majority of its life within the area that is being monitored. Only when this is the case can changes in population be tied to changes in the ecosystem within the monitoring area and not outside of it.

The harbor porpoise is the only cetacean found in the Pacific Northwest that is entirely resident to the inland waters of the Puget Sound.

***\* Harbor porpoises aren't endangered yet.***

An ideal sentinel species is sufficiently abundant that it is both reasonably easy to monitor and that the population can respond to changes in environmental conditions.

Very rare species will be too isolated, and not well distributed in the area to be monitored. Their small populations can be less responsive to, or much slower to respond to changes in environmental conditions, especially positive ones.

A more abundant species that at least has the potential to be well distributed across the area to be monitored can be a better indicator of both positive and negative changes in environmental conditions within localized areas. That information can more readily be applied across the studied landscape.

Harbor porpoises have been listed as a Species of Special Concern in Canada and they are a Candidate Species of Concern in Washington State. While significantly impacted by negative factors in the environment, harbor porpoises are not a threatened or endangered species. They are still relatively abundant and, potentially, well distributed throughout the Salish Sea.

***\* The harbor porpoise bears young frequently, allowing us to see if restoration efforts have been successful sooner.***

An ideal sentinel species will have a relatively fast reproductive rate, responding more quickly to changing environmental conditions. Populations with slower reproductive rates will exhibit more lag in their response to changing conditions.

Female harbor porpoises can produce one calf each year for approximately 15 years of their 20-year life span.

***\* Citizen scientists can monitor the harbor porpoise population.***

To be most cost effective, an ideal sentinel species must be relatively easy to monitor. Important considerations in the choice of a sentinel species are that it can be easily observed and that its distribution and population information can be easily recorded in an objective fashion without excessive costs.

Trained observers can distinguish the harbor porpoise from other marine creatures without much difficulty. They are also a species that people find intriguing almost instantly.

***\* A harbor porpoise's blubber holds pollution that we need to be aware of for our own health.***

Monitoring a sentinel species is primarily used to determine the health of an ecosystem, but, with certain sentinel species, scientists can also watch for threats to human health.

Harbor porpoises' blubber collects and stores pollutants. "The harbor porpoise, being vulnerable to pollutants, may be an excellent sentinel species for detecting high levels of pollutants in nearshore waters" (Money and Trites 1998).



*Phocoena phocoena*

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## Why the Harbor Porpoise, and not the Orca or Harbor Seal?



photo: Joseph Diepenbrock

While Orca and harbor seal research are vitally important to conduct and will provide information regarding the health of an ecosystem, they lack certain important characteristics that cause the harbor porpoise to be a better sentinel species for the health of the Salish Sea.

The resident Orca population is federally endangered. They have a long reproductive cycle and spend a significant part of their life cycle outside the monitoring area. It will take a long time to observe if the population is recovering and responding to environmental changes.

In contrast, the harbor seal population is doing very well and is at its carrying capacity. It is capable of withstanding significant environmental degradation without great impacts on the population. Thus it will be difficult to observe if the population is responding to any environmental changes.

The harbor porpoise doesn't migrate. It has a short reproductive cycle, is sensitive to environmental changes and once was found everywhere. These characteristics give researchers the ability to document their responses to environmental changes on a quicker time scale. This provides timely, critical information about the health of the ecosystem, making the harbor porpoise an ideal sentinel species.

The harbor porpoise is an indicator species in other areas such as the Baltic Sea. Canada's management plan recognizes that the harbor porpoise is a good indicator of ecosystem health because of "this species' apparent limited movement and moderately high position within the marine food web". We agree that the harbor porpoise population is a good indicator for ecosystem recovery of the Salish Sea, making it an ideal sentinel species.

## EXPECTED OUTCOMES & POTENTIAL BENEFITS

Pacific Biodiversity Institute's overall mission in conducting the Harbor Porpoise Project is two-fold:

- to perform novel scientific research to help assess harbor porpoise population status
- to translate our findings into knowledge usable by a broad spectrum of agencies, non-profits, and the public in conserving and managing the marine environment of Puget Sound

*This research project will:*

- 1) provide a new tool for population assessment
- 2) verify and calibrate new technological methods

*Specifically, it will:*

- 1) determine a population baseline for harbor porpoise utilizing Burrows Pass,
- 2) detect changes in that population over time, and
- 3) establish the use of Passive Acoustic Monitors as an effective, affordable technology for tracking harbor porpoise numbers continuously

Our research will benefit numerous agencies by filling critical information gaps in both monitoring technology and harbor porpoise population biology. The information we gather will first provide a population baseline. With this data we can then determine if/when any significant changes occur in the population. The ongoing data will be of great use to managers in determining how best to protect this little-known, but important, species.

Currently, there is a dearth of information available on harbor porpoise status in Puget Sound. WDFW has identified the harbor porpoise as a Species of Concern, but has not had the funding to complete the listing with a status review. By providing new tools to help guide policy and resource management in regards to conservation and recovery of the species, Pacific Biodiversity Institute's research will be contributing to the overall health and biodiversity of Puget Sound.

We believe this data will be useful to a range of audiences:

- federal and state agencies, such as NOAA, Washington Department of Fish and Wildlife, Marine Mammal Commission and Puget Sound Partnership
- non-profit groups, including the SeaDoc Society
- tourism businesses, such as those offering whale-watching cruises and kayaking tours
- concerned and interested individuals, including college and graduate students, citizen scientists, boaters and near-shore residents

### Characteristics of a Sentinel Species

An ideal sentinel species ...

- is sensitive to changes in its environment
- spends all, or nearly all, of its life within the proposed monitoring area
- is relatively abundant and evenly distributed
- reproduces on relatively fast timeline
- is easy to monitor
- is one that people value

### Characteristics of *Phocoena phocoena*

In Puget Sound, the harbor porpoise ...

- has experienced population declines and increases
- is a full-time resident
- is relatively abundant
- produces one calf each year for 15 years
- can be distinguished from other marine mammals in the area with minimal training
- is charismatic and intriguing, endearing itself to those who study and observe it



### **Study Site: Burrows Pass, near Anacortes, Washington**

Burrows Pass, between the Washington Park bluffs and Burrows Island, presented an ideal site for a study that combines acoustic monitoring (C-POD) with visual observation. We have observed porpoises traveling year-round through this narrow passage. Half the span is within the detection range of the C-POD array. At the same time, the entire channel is visible to observers from the headland above. Finally, Dall's Porpoise have never been observed in this locale during our four years of observations, so there is no acoustic or visual confusion with the harbor porpoise. *photo: jon, flickr*

### **METHODOLOGY**

PBI's methodology combines the best practices in marine mammal research with an innovative new approach to monitoring.

- **Use passive acoustic monitors (PAMs) to collect acoustic data recordings**

We have a Chelonia C-POD attached to a buoy in Burrows Pass, an observed harbor porpoise travel path. Data is recorded continuously for up to 3 months, and processed using proprietary Chelonia software. Data retrieved from the PAMs will be analyzed for presence, timing, and direction of echolocation clicks.

- **Observe the porpoise from land and sea**

Land-based observers positioned at an observation site on the headlands 51 meters above the Pass visually record presence of harbor porpoise in the vicinity of the PAMs. Time-stamped, high-speed, high-resolution photographs taken from this site will also be used to record harbor porpoise position and movements.

- **Calibrate the acoustic recordings with the visual data**

Time-synchronized visual, photographic, and acoustic data will be correlated to estimate the acoustic range of the PAMs in detecting harbor porpoise.

Continuously-recorded acoustic data will enable us to deduce harbor porpoise numbers and movements, even when visual observations are not possible.

- **Analyze long-term data trends**

The data we collect, combined with continued opportunistic visual observations by citizen scientists, will be used to assess diurnal, seasonal and annual trends in their presence.



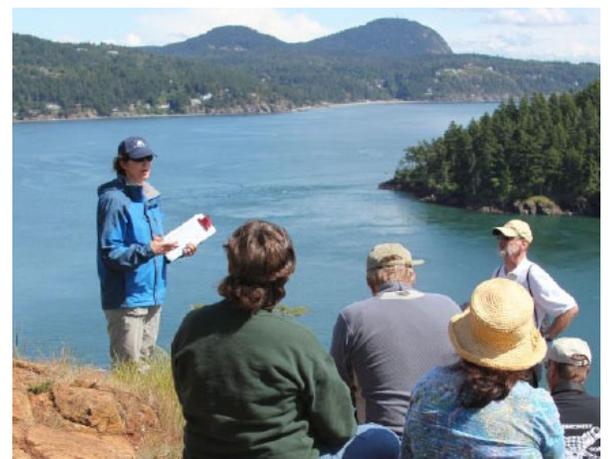
*Aileen Jeffries, Principal Investigator, has transferred her training from physics research to apply acoustics to cetacean echolocation.*

### **OUR CITIZEN SCIENTISTS**

In 2010, PBI's Harbor Porpoise Project reached a point where having more observers scanning Burrows Pass would help. We put out a call and the Skagit County Beach Watchers responded.

Involving local residents of Anacortes has been a boon to our ability to collect data. More importantly, it also fosters a sense of responsibility and stewardship for our coastal ecosystems.

In the long run, the key outcome of PBI's research could be increased public confidence that ecosystem conditions are actually improving as restoration efforts proceed. After all, morale improves when you can see the progress!



*Many members of the Skagit County Beach Watchers have been trained as harbor porpoise observers. PBI's harbor porpoise observers carefully note their porpoise sightings in ten-minute increments for two-hour periods.*

## EARLY FINDINGS

In the four years since Pacific Biodiversity Institute initiated this project, we have established a number of elements of the natural history.

At our observation site in Burrows Pass, we have detected:

- \* a seasonal trend in porpoise presence
- \* a diurnal cycle in porpoise presence
- \* greater presence overall than expected
- \* the appearance of calves in August
- \* occasional large aggregates of over 80 porpoises

All of this information contributes to what is known about this species, but it also raises new questions. What we hope to learn about the harbor porpoise through continued study could prove much more useful.

## EXTENDING THE SCOPE

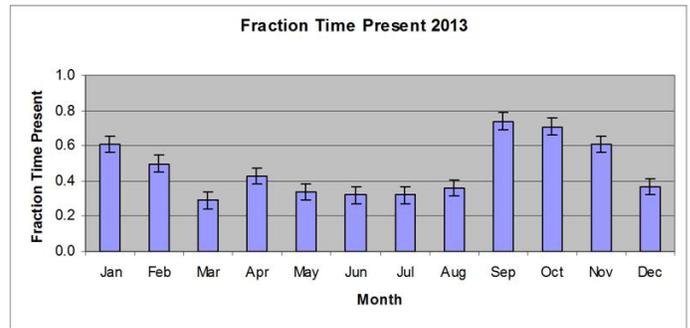
Although the results from the present study will apply to the Burrows Pass area, the technology can be used to create a sampling net anywhere in the Washington Inland Waters.

Now that we have developed and fine-tuned these monitoring techniques, we are beginning to partner with other groups to deploy PAMs in other locations around Puget Sound, to assess other areas that harbor porpoise frequent. In the future, this same technology could be used to assess the potential influence of anthropogenic noise (e.g., from boat traffic) on harbor porpoise. With increasing concerns over the levels of anthropogenic noise in the sea, and its effects on marine mammals, such information will be important to a variety of entities, from marine managers to tourism businesses.

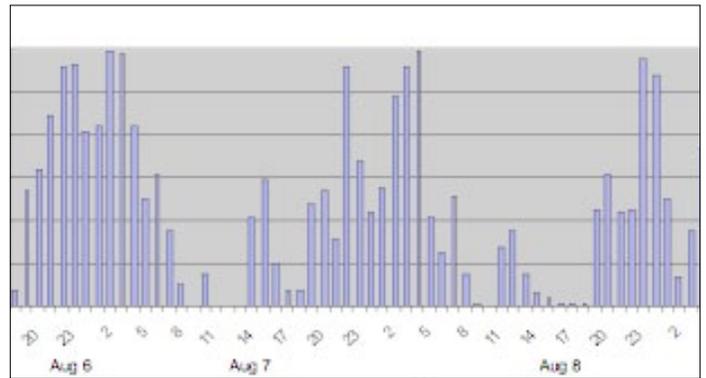
The animals passing through Burrows Pass will likely be within acoustic range of more than one monitor. As we add monitors, we can provide a robust data set for the development and calibration of this new acoustic method.



*Involving citizen scientists in the monitoring effort is a key step in cultivating stewards for the Salish Sea and the harbor porpoise.*



*Data collected in 2011 through 2013 shows that harbor porpoise sightings in Burrows Pass decreased through the summer, then began to pick up again in August.*



*PBI's tests will help to show that acoustic monitors could be also be an effective tool for population assessment of other marine mammals.*

## EFFECTIVE MONITORING ALLOWS US TO SEE IF RESTORATION EFFORTS ARE WORKING

Monitoring the health of the Salish Sea ecosystem is a priority for the current conservation, restoration and clean-up efforts directed at this ecosystem. Without objective monitoring, it will be impossible to gauge whether efforts to restore this high-value ecosystem have been effective.

The Inland Waters stock of harbor porpoises meets all the characteristics of an ideal sentinel species for the Salish Sea, and it can be monitored effectively using a combination of passive acoustic monitors and visual observations.

As we learn more about the harbor porpoise, our understanding of the complex ecological interactions that maintain ecosystem health will increase. Understanding these interactions is critical to our future success in maintaining the health of this immensely valuable ecosystem.

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