Land-based Observations of Harbor Porpoise
Burrows Pass 2011 to 2013

Pacific Biodiversity Institute

Locations of land-based observations

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March 2014

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RECOMMENDED CITATION
Jeffries, A. 2014. Land-Based Observations of Harbor Porpoise Burrows Pass 2011 to 2013, Pacific Biodiversity Institute, Winthrop, Washington. 23 p.

ACKNOWLEDGEMENTS
Mary Johnson skillfully edited this report. Dr. Cindy Elliser made a number of helpful changes. An exceptional team of volunteer citizen scientists collected much of the observation data reported here under the leadership of Sue Ehler, the Observer Coordinator. Please read Appendix A to learn about their contributions.

PROJECT FUNDING
The work described in this report was funded by the Charlotte Martin Foundation, Mountaineers Foundation, Kongsgaard-Goldman Foundation, Friends of Skagit Beaches, and two anonymous donors to Pacific Biodiversity Institute.

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Abstract

The harbor porpoise (*Phocoena phocoena*) demonstrates a strong presence in our study area, which includes Rosario Strait from the northeast point of Orcas Island to Deception Pass and east to Padilla and Skagit Bays. Since 2009, PBI research scientists and citizen scientists have visually observed and acoustically recorded the porpoises in this area to learn their distribution, abundance, and behavior. As a result of our study, the instruments and techniques have been validated as a useful and productive approach to studying the harbor porpoise.

The study has shown that harbor porpoises are present in the Rosario Strait area all year, with a strong presence in Burrows Pass. Their occurrence changes seasonally, and they are more often present in the winter months. We are able to show that the diurnal presence detected by the acoustic monitoring is also supported by the land-based observations. We have found several additional locations with apparently high concentrations of harbor porpoises, including the southeast point of Guemes Island and Biz Point in Burrows Bay. In the summer, the porpoises are regularly observed in Rosario Strait, sometimes in very large concentrations of over 50 porpoises.

Porpoises bring their calves to Burrows Pass. They are first observed in August and are seen regularly through December after which the calves become too large to reliably identify. The porpoise in Burrows Pass show several behaviors that can be easily recognized including traveling, breaching during intense foraging efforts, occasional tail slaps and mother-calf synchronous swimming and diving. Porpoises are present on average more than 40% of the time, and they are most often seen singly or in groups of 2 to 5. During some feeding observations, multiple groups of 2 to 6 (8 to 10 individuals, total) have been seen in the pass at the same time.

The porpoises are seen to regularly pass by or feed around Biz Point and Casperson Point, the southeast point on Guemes Island. Limited sighting data indicates that relatively few spend time in Guemes Channel. Porpoise were not seen at Rosario Head, possibly because orca were present when the observations were recorded there. We regularly recorded opportunistic sightings in Rosario Strait between Cypress, Sinclair, and Orcas Islands.

Background

The harbor porpoise has been difficult to monitor, and thus little is known about the population. The harbor porpoise is small and has non-distinctive coloration: gray on the dorsal side and light grey on the ventral side. It is known to be furtive and to avoid boats (Flaherty et al. 1982, Prescott 1980). The harbor porpoise was abundant in Puget Sound in the 1950s (Scheffer et al. 1948). After that time its population dropped so dramatically that by 1990 it was no longer seen in southern Puget Sound and rarely seen in other areas (Flaherty et al. 1982, Calambokidis et al. 1993, Calambokidis et al. 1994, Baird et al. 1994, NOAA 2011).

This report describes preliminary testing and assessment of the use of land-based observations to study the species and track its movement and distribution trends.

NOAA has a mandate to conduct harbor porpoise stock assessments every 3 to 5 years under the Marine Mammal Protection Act, 1972, but the most recent aerial surveys are over 10 years old (Calambokidis et al. 2003, Chandler et al. 2003). The Washington Department of Fish and Wildlife (WDFW) has identified the harbor porpoise as a Candidate Species of Concern but has had neither the funding nor information to complete the listing with a status review (WDFW 2013). British Columbia has listed the porpoise as a Species of Special Concern (Baird 2003).

The expense of monitoring every component of a complex ecosystem is clearly out of the range of public agencies that are struggling to cope with extensive budget cuts. Compared to other methods, PBI's use of passive acoustic monitors, C-PODs, is inexpensive and provides continuous records. Moreover, this new technology allows a species that has been too difficult to study to become an easily monitored indicator for the ecosystem. Ongoing population assessments of this species will first help to fill a critical information gap and then provide a significant complement to NOAA's aerial stock assessment surveys once those are conducted again (NOAA 2003). The ability to establish an accurate baseline population and then to monitor population changes in a timely, cost-effective manner will prove valuable to all of the agencies involved in the recovery of this species.

PBI has been able to collect significant data through the help of citizen scientists. We have shown that land-based observations can record reliable data and are a valuable addition to a project with limited resources. Land-based observations have not been commonly used in the northeast Pacific with a few notable exceptions: Calambokidis conducted an assessment of the amount of time harbor porpoises were above the water surface and could be observed in order to calibrate aerial survey work (Calambokidis et al. 1993, Laake et al. 1997). Culik used a theodolite from land-based observations in Claquot Sound to demonstrate the effectiveness of pingers in displacing harbor porpoise (Culik et al. 2001). Jefferson did a study of Dall's porpoise at the northern end of Vancouver Island (Jefferson 1987).

Population assessment surveys of harbor porpoise in the eastern Pacific have generally been aerial or boat based (Chandler et al. 2003, Hall 2011, 2004, 1996, Zerbini 2011, Barlow 1988, Oleson et al. 2009, Calambokidis et al. 2004).

Data and techniques from PBI's ongoing research can help guide the appropriate protective measures required to maintain strong and sustainable harbor porpoise populations consistent with a healthy ecosystem in the Salish Sea. Our project is contributing to a better understanding of an ecosystem-based approach to managing, protecting, and restoring this important species.

Location

Our primary study site at Burrows Pass, located between the Washington Park bluffs and Burrows Island, is an ideal site for a study that combines acoustic monitoring with visual observation. We have been studying harbor porpoises at this site and the associated areas of Rosario Strait and Burrows Bay since 2008 (Jeffries 2011). Our visual and acoustic studies extend from Sinclair Island in the north, down to Deception Pass to the south. Based on our work in this region, Burrows Pass has the most frequent occurrence of harbor porpoises, which makes it the ideal site for testing land-based techniques and acoustic instruments for our work.

Our primary observation station, 51 m above the water, has a clear view of the entire channel. Burrows Pass is 450 m wide at the narrowest location and generally is 500 to 600 m across. The pass can run strong currents up to 5 knots. The depth is 20 to 60 m with rocky walls and kelp beds on the north side. Divers refer to the north side below the Washington Park bluffs as "Skyline Wall" and report a wide variety of fish including rock fish, smelt, cod, and blackmouth. Porpoises, seals, and river otters are regularly seen here. There is a lingcod hole at the northeast point of Burrows Island, coincidentally at the same location as the monitor. Our observers have reported 28 different bird species here. Invertebrates in the area include plumose anemone, sea urchins, and giant barnacles. We have observed porpoises traveling through this narrow passage year-round. Dall's porpoise have never been observed in this locale, eliminating potential confusion with harbor porpoise, either visually or acoustically.

Methods

In 2009–2010, we began testing ways to collect observational data on harbor porpoises. We learned what information we could collect, and from that information we developed a protocol.

- In 2010, interns and volunteers spent over 105 hours observing on 31 days at Burrows Pass.
- In 2011, we observed for 97 days and collected 332 hours of observations with 12 observers.
- In 2012, we observed for 80 days for 174 hours of observations with 14 observers.
- In 2013, we observed for 109 days for 217 hours with 12 observers.

Land-based observers positioned at an observation site on the bluff above Burrows Pass have tested observations with the aid of binoculars, photographic techniques, and theodolite tracking. The porpoises appear so quickly that unaided visual sightings were found to be both

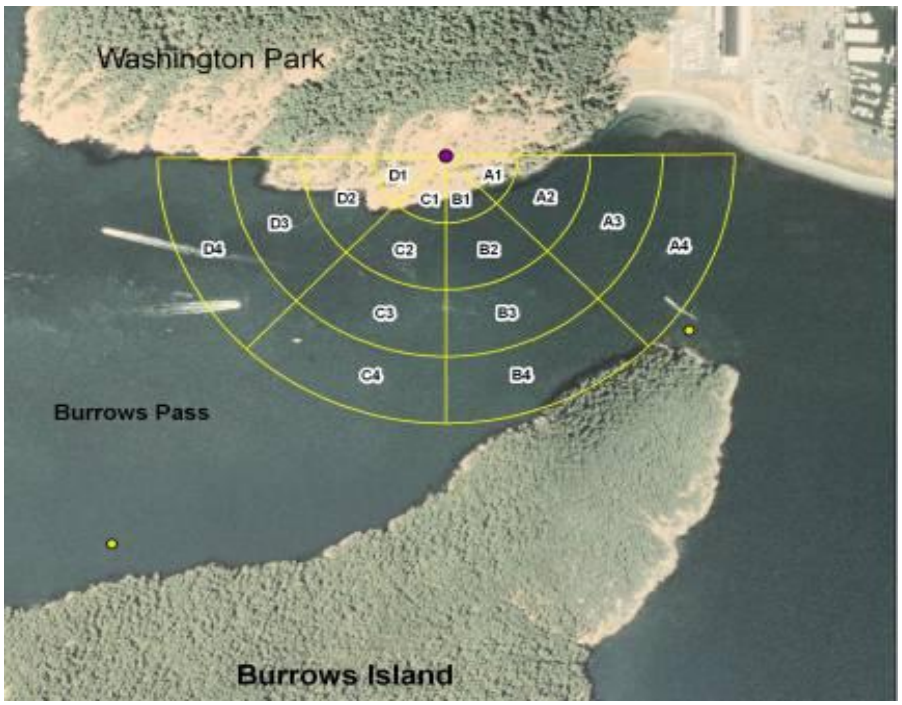
necessary and effective in order to scan the whole area quickly. We will use the other methods when accurate locations are needed. The visual observations reported here are unaided sightings supplemented with binoculars. Observers use polarized glasses whenever possible. To assure proper identification of the porpoises, the observers are trained and tested for their ability to identify all species that might be seen in the area: harbor porpoises, Dall's porpoises, orcas, Pacific white-sided dolphins, Risso's dolphins, harbor seals, stellar and California sea lions, river otters, grey whales, and humpback whales.

Our visual observers are trained to use a protocol that uses a 10-minute interval to measure the observation effort and explicitly quantify the data recorded. They observe for a 2-hour period recording data in 10-minute increments. The data they record for each 10-minute increment represents the average location (center of mass) in which they observed each group of porpoises, and it represents the maximum number of porpoises they are sure they observed in that time increment. A 10-minute interval gives the observer time to assess how many groups are present in that interval and is usually long enough for them to see all the porpoises that are present. When observations are recorded for 2 hours, it is usually apparent how many groups consistently appear and how they are moving. The observers also record weather, temperature, wind speed, Beaufort scale, other species that are present, and how many boats pass by. We have emphasized to the observers, "An observation of *no porpoises* is important data," so extensively that it has become the observer's joke.

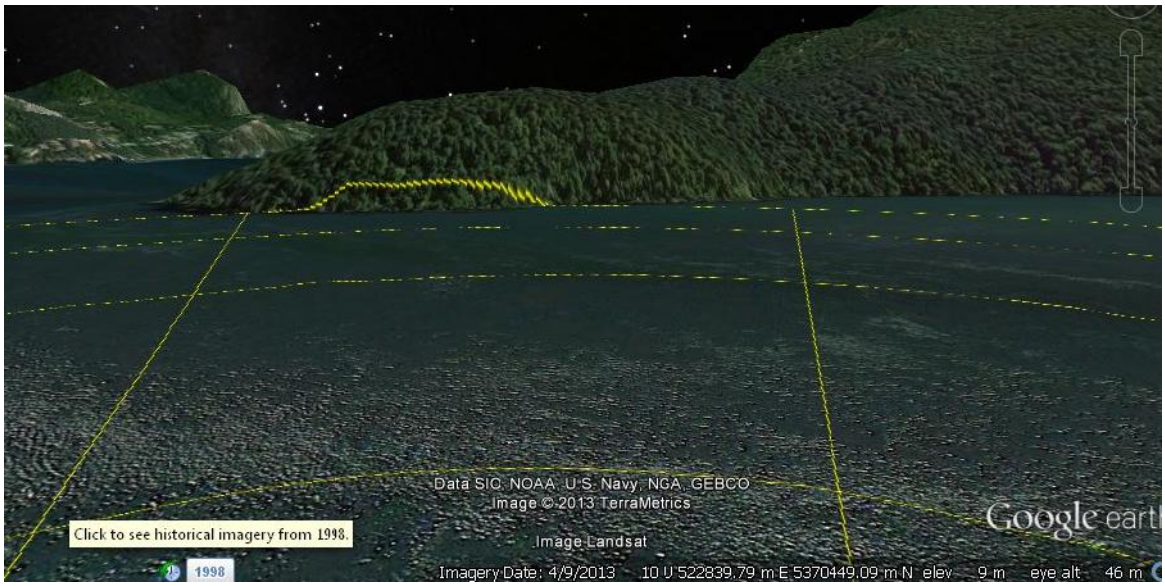
Through much of 2013, we were testing methods to establish a probability of detection for the observations in Burrows Pass in order to compute densities of harbor porpoise. The difficulty of judging the distance/location of the porpoises required the development of additional aids to ensure that the observers were consistent in identifying the correct grid cells. Due to this difficulty, we collapsed all the location information for 2011 through 2013 and only analyzed the presence/absence of porpoises and the maximum number that were present in observed 10-minute intervals.

In 2012, we attempted a number of other locations and methods for collecting observation data. We have tried having observers walk along paths by the water along the South Shore on Guemes Island and the Guemes Channel Trail in Anacortes. We have a limited number of observations from Sar's Head and Rosario Beach, shown on the map as the Rosario Beach Trail. Opportunistic observations are called in regularly from boats and various land locations through the Rosario Strait area from Sinclair Island to Deception Pass. Home-based observers from the southeast point of Guemes Island and Biz Point in Burrows Bay were remarkably successful in large part because of two dedicated observers who have kept records since 2012. In 2013, we concentrated on the Burrows Pass observations and collected other sightings as opportunistic.

Visual observations from 2009 to 2013 have primarily been from the bluff at Burrows Pass in Discover Park in Anacortes. Observers identify which grid cell the porpoises are sighted in for every 10-minute interval. At our observation location the horizon cannot be seen, and the grid shown below serves as a surrogate for azimuth and declination to identify location.



We have tested additional aids, such as reticular binoculars and theodolite apps, and have selected a draped grid transparency that the observer can hold in front of them to check the porpoise location. This location tool will be used for future observations, and we are developing methods to test its accuracy. An example of the grid this tool creates is shown below.



Data Analysis

Observers watch for a total duration of 2 hours under most circumstances. They write their observations onto paper forms and record the number of porpoises, average location for a 10-minute interval, behavior, a note of other species present, weather information, and the time of the observation. The "unit of effort" is the 10-minute interval. The observer then types this data into a digital form and for redundancy emails the data to two recipients. The data is checked for legibility and consistency when it is received, and the observer is called if there are questions. This data is broken into two sets of information: (1) "header," which consists of the observation site, name of the observer, date, time, Beaufort scale, wind speed, temperature, and the strength of a reference tide rip, and (2) "data," which consists of the time-referenced observations of number of porpoises, grid cell location, and notes. At the end of each year, these two sets of data are imported to a Microsoft Access database for analysis. The two sets of information are related to each other by the time and the observer.

The observation data for 2009 through 2013 has not been analyzed with reference to the sighting location of the porpoise. As stated earlier the data was collapsed to indicate whether porpoises were present or not present and to indicate the total number of porpoises that were present. We do find that having a grid location helps the observers to be aware of the different groups of porpoises that are present at one time. Often, as many as three or four groups are present.

The data is first analyzed to compute fraction time present by day and by month. This consists of the sum of all the 10-minute intervals by the day and the month in which porpoises were present divided by the sum of the 10-minute intervals for which an observer collected data. The second measure computed is the average number of porpoises present by day and by month, which is calculated from the maximum number of porpoises seen in each 10-minute interval averaged over the 10-minute intervals for that day. A standard deviation is calculated for these averages. The standard error is computed for the fraction time present. These are displayed as error bars with the data.

The home observations are collected in 15-minute intervals at various times during the day, and these observers often recorded observations several times per week. The walking observations along Guemes Channel were collected for an interval of 1 hour while walking the trail. Opportunistic observations were called or emailed in randomly from boat or land and usually were just a one-time sighting with the number of porpoises, date, and location. These opportunistic observations are particularly valuable because they include the occasional aggregations of over 50 porpoises that occur in Rosario Strait.

Results

The results reported in detail here show the fraction time present and average number of porpoises by month for the Burrows Pass observation site data for 2011, 2012, and 2013 (Figures 1–6). Observations from 2010 (Figure 7) are included also for comparison (Jeffries 2011). There was significantly less data for 2009 through 2010 because we were assessing whether it would be possible to collect land-based observations during this period of time. Other results include home observation, opportunistic sightings, and a brief summary of observations from different test sites. No orcas have been sighted in Burrows Pass in the 4 years we have collected observations. They have been seen 3 times in Rosario Strait at the junction of Rosario Strait to the Pass and they were subsequently observed to travel away from Burrows Pass down the Strait. One humpback whale and calf were sighted traveling through the pass. Many seals and occasional sea lions and otters are observed in Burrows Pass and recorded.

For Burrows Pass there is a clear seasonal pattern with the greatest fraction time the porpoises are present being from September into March. There is a significantly lower fraction time present for mid-March into August (Figures 1, 3, and 5). The other variable shown is the average number of porpoises present in the pass for 2011, 2012, and 2013 (Figure 2, 4, and 6). The standard deviation for this value is often high because it is complicated by the fact that for significant intervals of time there are no porpoises present, and then for another long interval of time porpoises will be present constantly. We will be testing zero-inflated models or a standard negative binomial regression model to handle this characteristic.

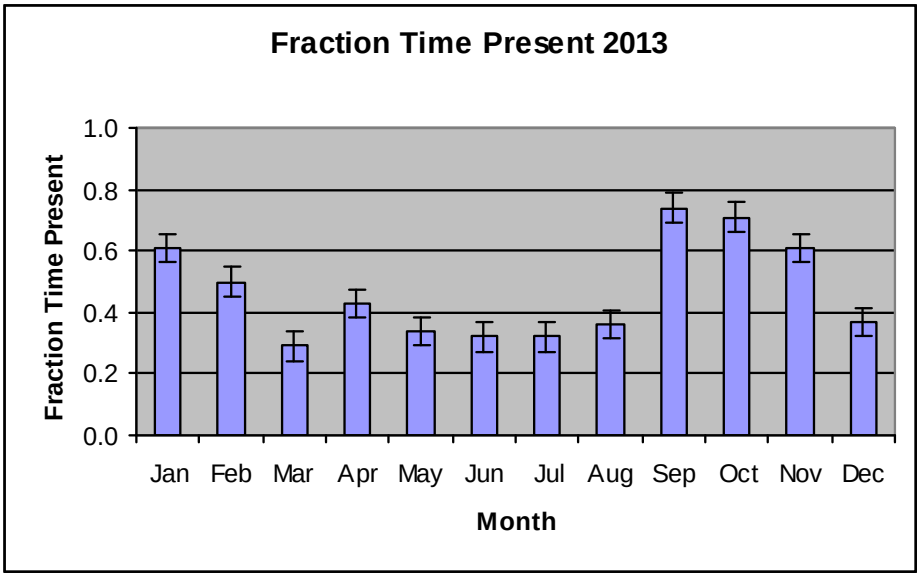


Figure 1. Land-based observations from Burrows Pass. The fraction time porpoises are present by month for 2013.

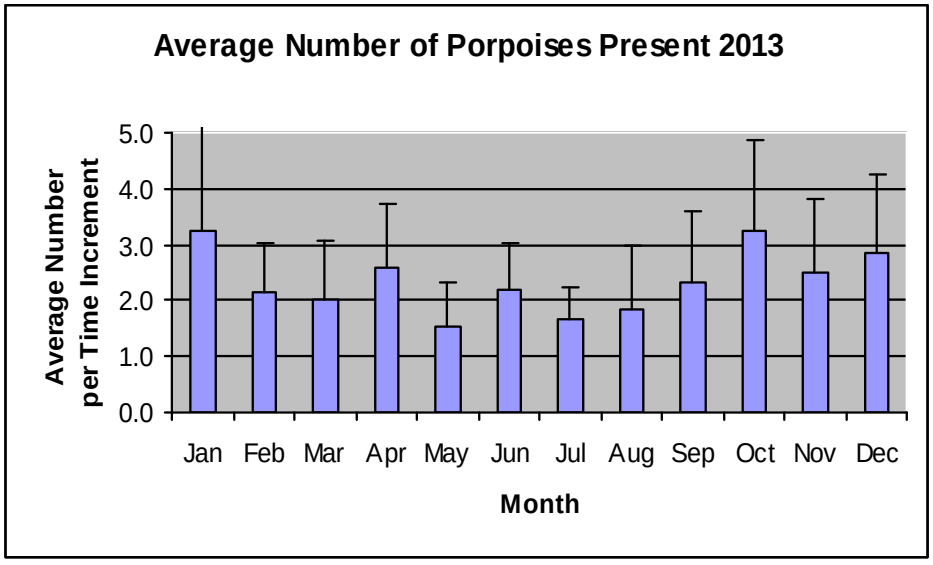


Figure 2. Land-based observations from Burrows Pass. The average number of porpoises present by month in 2013.

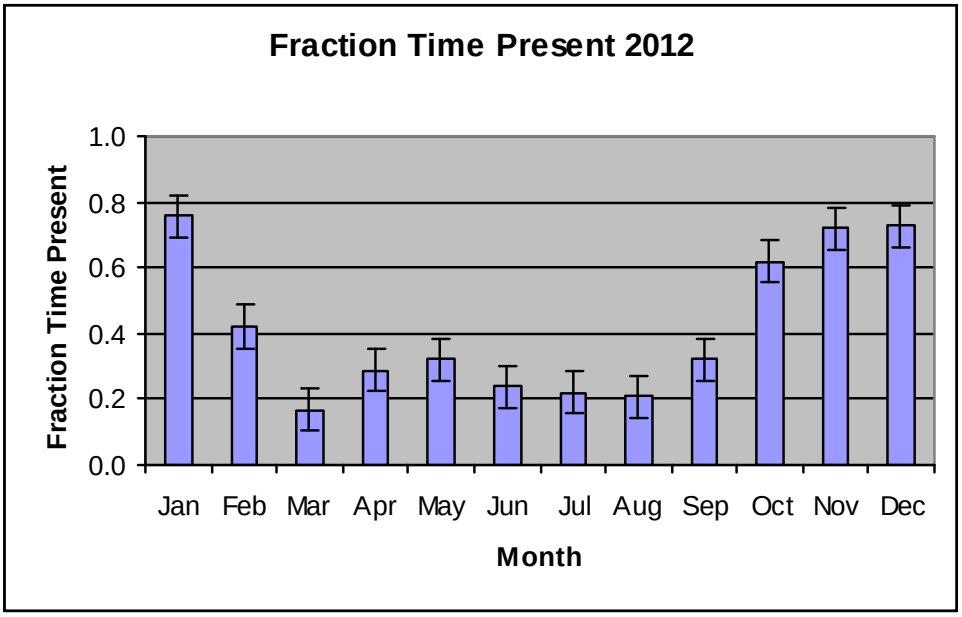


Figure 3. Land-based observations from Burrows Pass. The fraction time porpoises are present by month for 2012.

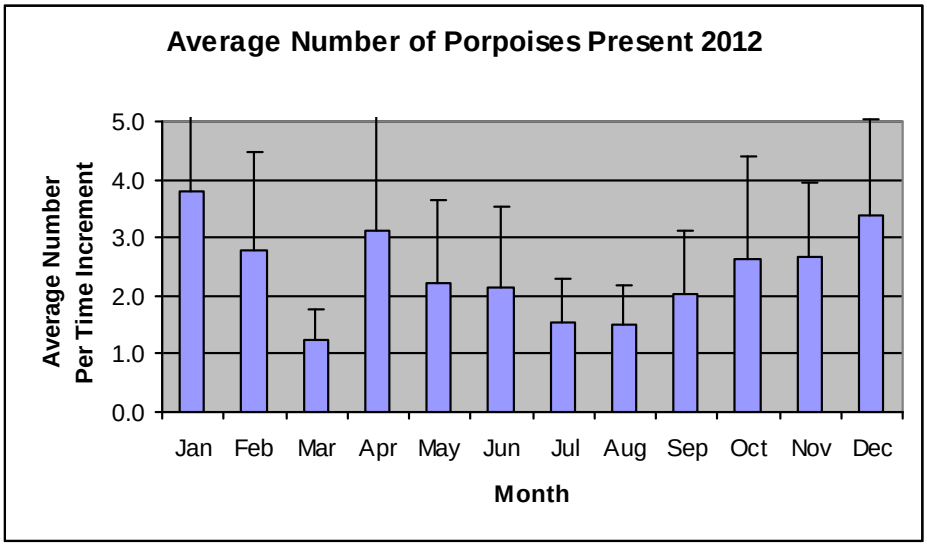


Figure 4. Land-based observations from Burrows Pass. The average number of porpoises present by month in 2012.

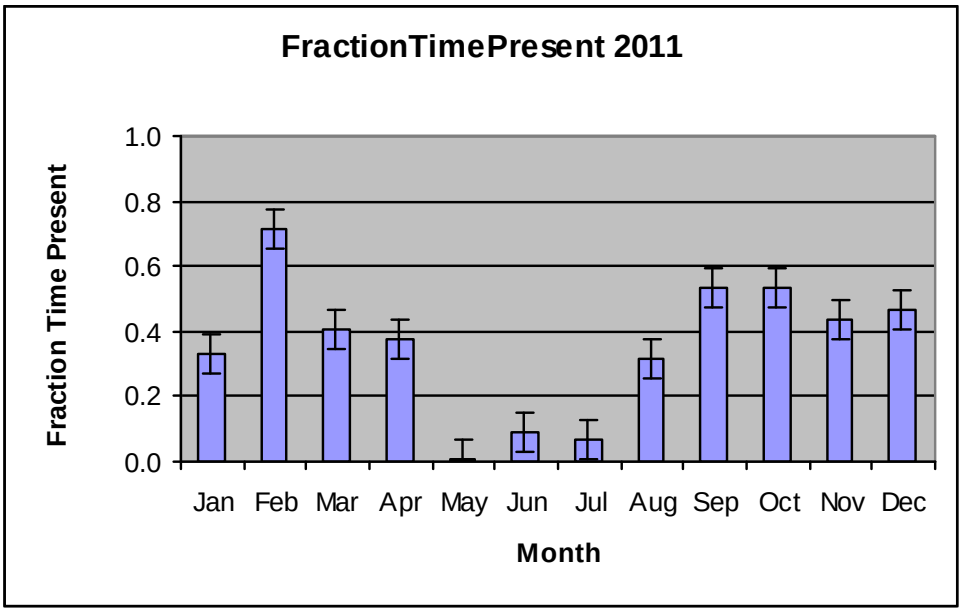


Figure 5. Land-based observations from Burrows Pass. Fraction time porpoises are present by month for 2011.

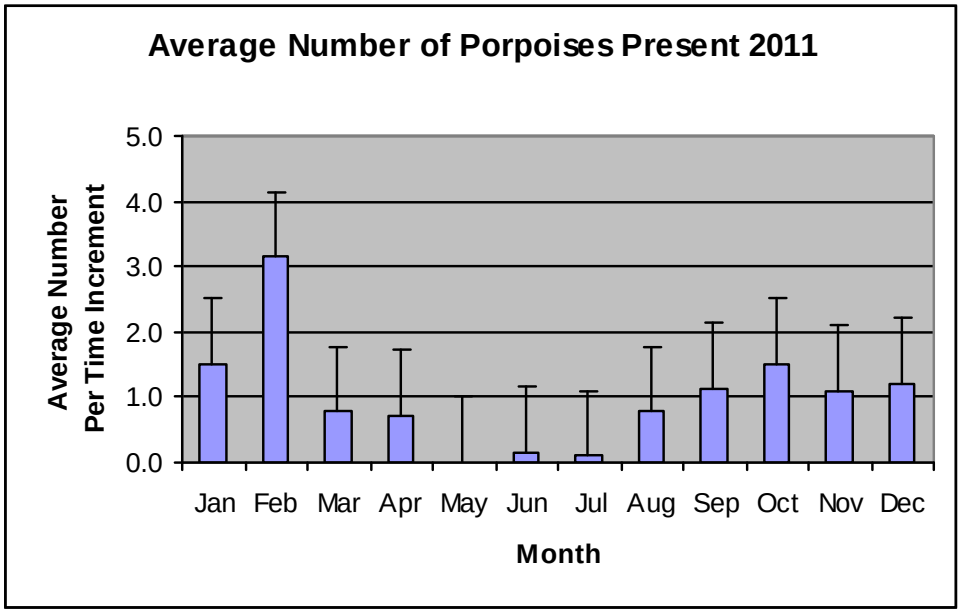


Figure 6. Land-based observations from Burrows Pass. The average number of porpoises present by month in 2011.

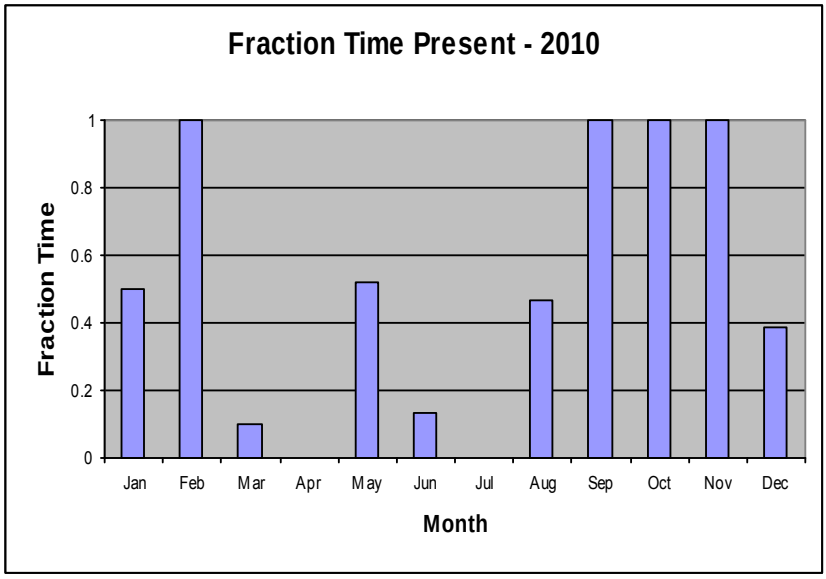


Figure 7. Land-based observations from Burrows Pass. The fraction time porpoise were present by month for 2010.

In August the mothers and calves begin to appear about the middle of the month (Figure 8). This timing of first appearance has been surprisingly regular. The pairs are most evident in August through December because during that time the calf is quite small and swims synchronously, usually in echelon position, with its mother. After December the pairs are still sighted, but the calf moves more independently and is larger and harder to clearly identify. There is often a third adult with the mother-calf pair.

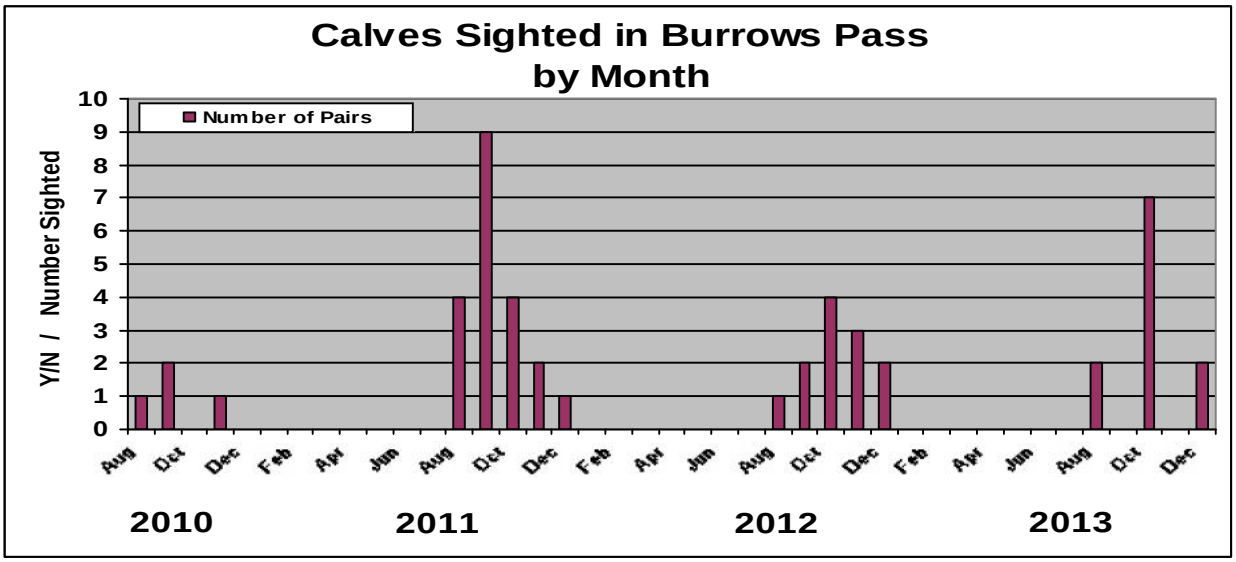


Figure 8. Calf sightings in Burrows Pass by month 2010–2013.

We receive reports of opportunistic sightings of harbor porpoise from land and boats (Figure 9). Occasionally, groups of up to 100 harbor porpoises have been sighted as large aggregates in Rosario Strait. We do not have sufficient data to indicate seasonality.

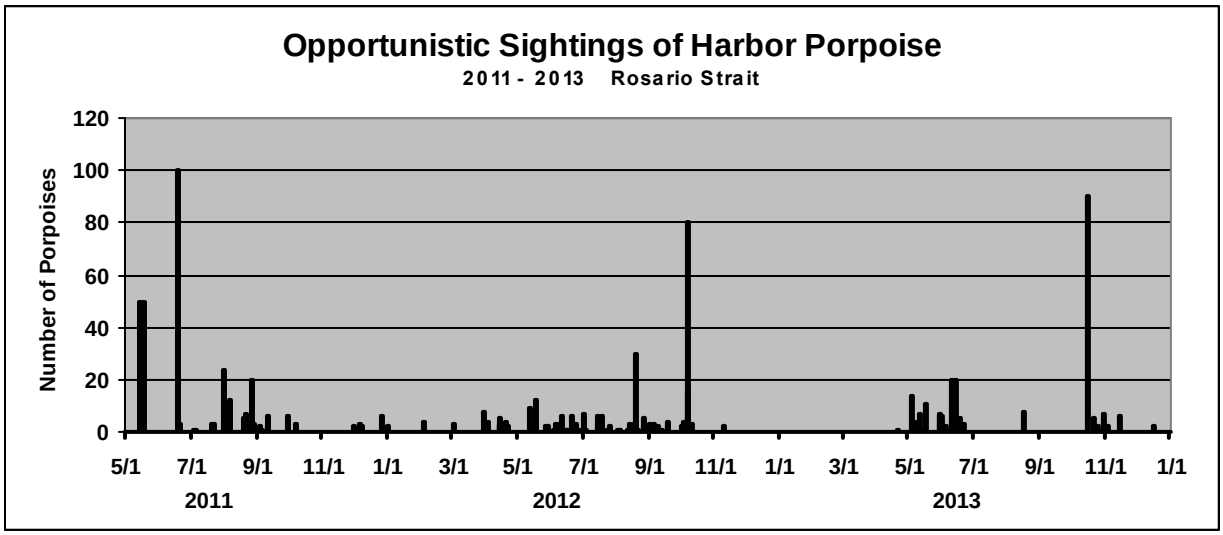


Figure 9. Opportunistic sightings in Rosario Strait 2011–2013.

Our acoustic data shows clear diurnal patterns of porpoises present (Jeffries 2012). We looked for this in our observer data by averaging the fraction time the porpoises were present by month for an entire year, 2011, for times when there was sufficient data. The histogram in Figure 10 shows a lower presence in the middle of the day than earlier or later in the day, which is consistent with the diurnal cycle reported by the acoustics.

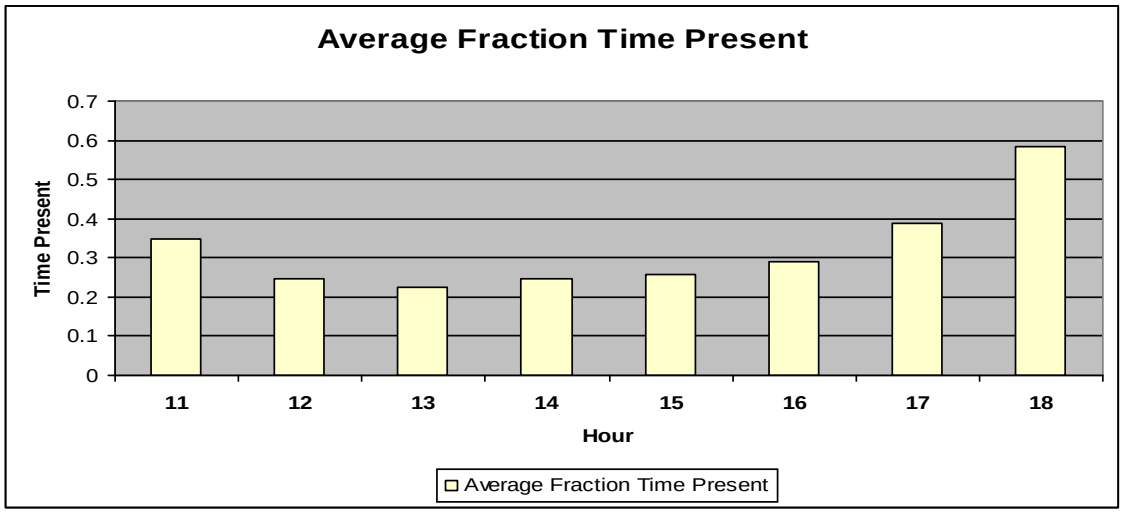


Figure 10. The fraction time present averaged by hour for Burrows Pass to compare to acoustic diurnal cycle.

Data from our home-based observations are shown in Figures 11 and 12. A record of no porpoise present during the observation period was plotted as a"-1" so that the chart would be easier to read. For example, at Casperson Point from October through December 2012 and from March through April 2013, there were many days in which no porpoises were present. And from September 2012 into October 2012 and in May 2013, porpoises were regularly present. There is no data for July 2013 and August 2013 in this chart.

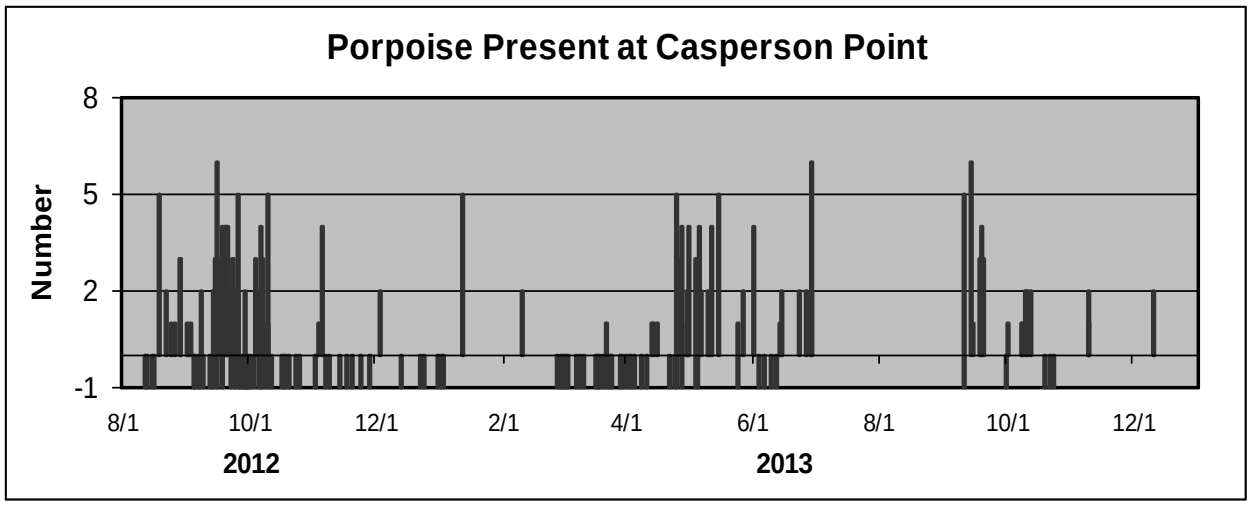


Figure 11. Home-based observations at the southeast tip of Guemes Island, Casperson Point for 2012 and 2013.

At Biz Point, the porpoise appeared in larger groups in 2013 (Figure 12). There was no apparent seasonality in their presence and no obvious reason for the larger groups. These home-based observations tell us that porpoise regularly use the waters at these two locations.

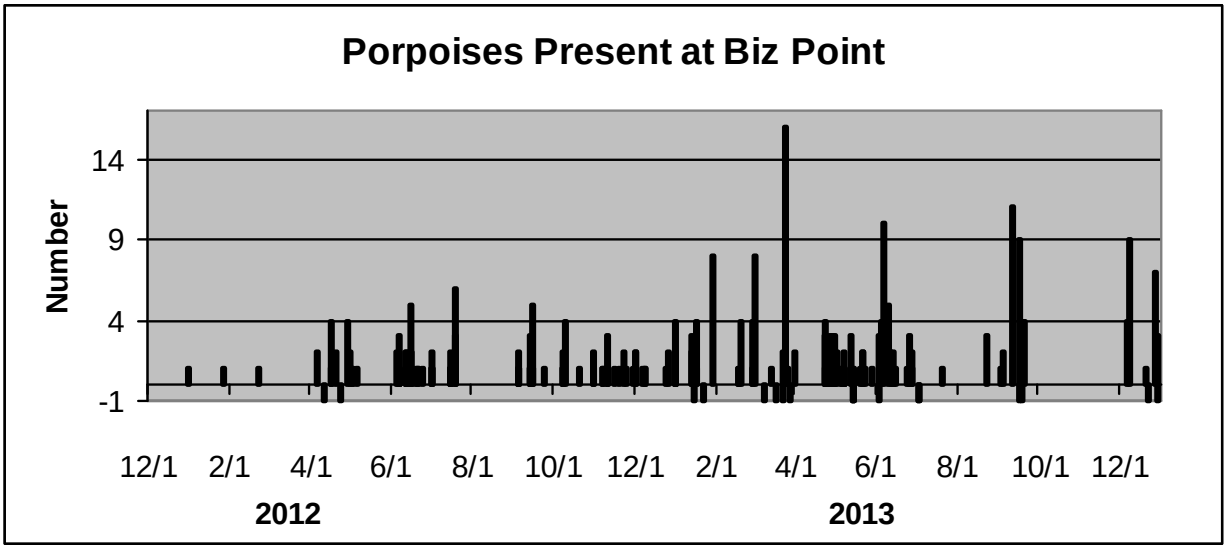


Figure 12. Home-based observations at Biz Point for 2012 and 2013.

Other locations and methods were tested in 2012. Observers watched the Guemes Channel waters from the Guemes Channel Trail in June through August while walking this trail and recorded if they sighted porpoises. They observed heavy boat traffic but not many porpoises (Figure 13). The trail was judged to not be high enough above the water to be a good location for observations.

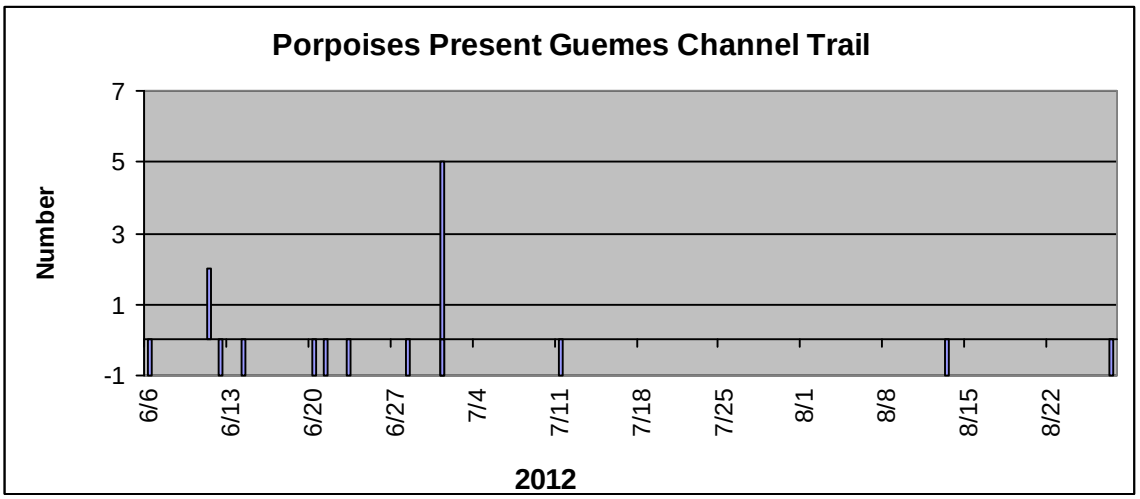


Figure 13. Walking observations from Guemes Channel Trail.

In July and August, we had four observations from Cap Sante. There was heavy boat traffic but no porpoises. In August and September an observer watched along the beach trail on Guemes Island near the ferry but sighted no porpoises. In June, there were two observations from the Rosario Head. Both times orcas were present, and no harbor porpoises were observed.

Discussion

Porpoises are observed in Burrows Pass during the entire year. They use this area for travel, foraging, and raising their young. Porpoises are observed here more than 40% of the time. The home-based observations demonstrate that porpoises are regularly present at Casperson Point and Biz Point. In the other areas for which we collected observations they were seen less than 10% of the time. Large aggregates are observed once or twice a year in the Rosario Strait area and have been seen in May, June, August, and October.

Observations show that when present, the porpoises are often present in a loose aggregate of small groups, and they are generally either singles and doubles passing through or several groups of two to five foraging. We are training our observers to accurately identify locations and expect to be able to estimate density in the future.

The data collected at Burrows Pass has given us information about the porpoises' presence and cycles of presence. It shows seasonal cycles, with porpoises being seen more frequently in the winter than in the summer. The land-based observations indicate the same diurnal pattern that our acoustic monitoring has shown. Mothers and calves are sighted from mid-August into December. We will be refining our protocol to allow us to compute density for Burrows Pass in the future and further analyzing the data from 2011 through 2013.

These cycles of presence and varying group sizes may be linked to prey distribution/abundance, lifecycle events (reproduction/mating), and movements between important areas. However little is known about how the porpoises use these inland waters and why certain areas are important to them (for feeding, mating/breeding, travel, or resting). This research and our ongoing study are beginning to shed light on these important questions and will continue to provide information that will help guide conservation and future research on this species.

The Proceedings of the First International Conference on Marine Mammal Protected Areas (Reeves 2009) stressed the importance of habitat, travel corridors, and usage to identify locations suitable for marine protected areas. New Zealand requires protected areas based on critical habitat (Reeves 2009) and has demonstrated increased survival of Hector's dolphins following the creation of two such areas. Other studies have come to similar conclusions (Booth 2010, Goodwin 2008). The work in this report demonstrates the use of the Burrows Pass area for travel, foraging, and raising young, which indicates that this may be a critical area for porpoises. The information we have presented here is useful for selecting areas for protection.

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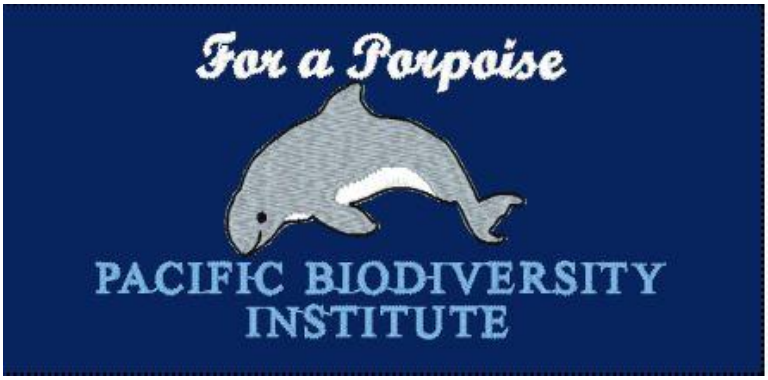
Appendix A

The Anacortes community has been welcoming and supportive of PBI's research. Over 150 people have attended our presentations describing our work. Of these more than 50 have volunteered significant time to collect observations data.

PBI's Volunteer Coordinator and Field Assistant, Sue Ehler, has done a remarkable job of working with and training our volunteers. She is the person who receives one set of the observation data and reduces it to a single spreadsheet to input and process in Microsoft Access. We could not have done this work without her.

Listed below are the stalwart volunteers who put in more than 20 hours of observations and were awarded PBI Harbor Porpoise Observer Caps. Many of these people put in far more than 20 hours. We cannot thank them enough.

Anne Casperson
Bob Weathers
Chris Brown
Connie Walser
Gordon Sjogren
Jan Hersey
Lin Folsom
Mike Mohundro
Pattie Hutchins
Sue Ehler



PBI is extremely fortunate to have two home-based observers, Anne Casperson and Jan Hersey, who have kept records over a period of almost two years. Having this kind of record over an extended period of time will allow us to try to correlate the porpoise's presence with other factors such as calving, forage fish seasonal locations, and forage fish spawning seasons.

Special thank to observers Roz Krumm and Matt Kershbaum, who watched the Guemes Channel waters; Mike Mohundro, who observed from Cap Sante; Dvon Havens, who observed along the beach trail on Guemes; and Regan Weeks, who observed at the Rosario Head.

The complete volunteer list for 2011 through 2013 is listed on the following page with thanks!

2013

Allan Burke
Anne Casperson
Bob Weathers
Bruce McDanold
Chris Brown
Cindy Young
Connie Walser
Ed Ehler
Fred Burke
Gordon Sjogren
Jan Hersey
Phil Green
Lin Folsom
Mike Mohundro
Morty Cohen
Pattie Hutchins
Phyllis Bravinder
Roberta Beecher
Roz Krumm
Tim Maher

2012

Andrea Doll
Anna Kagley
Anne Casperson
Betsy Scholze
Bob Freedman
Bob Weathers
Bonnie and Matt Kirschbaum
Bruce McDanold
Chris Brown
Cindy Young
Connie Walser
Dick Shiley
Dyvon Havens
Ed Ehler
Gordon Sjogren
Jan Hersey
Karen Richman
Lin Folsom
Mike Mohundro
Morty Cohen
Pattie Hutchins
Phil Green
Phyllis Bravinder
Regan Weeks
Robin Willis
Roz Krumm
Russ Barger
Sue Ann Gifford
Suzanna Epler
Scott Peterson
Tim Schmidt
Wayne Husbey

2011

Barbara Selfridge
Beckie Arnold
Catherine Davis
Chris Brown
Chris Wood
Chuck O'Clair
Ed Ehler
Gordon Sjogren
Jan Hersey
Jim Arnold
Laura Hamilton
Matthias Kerschbaum
Mike Mohundro
Pattie Hutchins
Rachel Benbrook
Robin Willis
Sue Ehler
Sue Mitchel
Sue Ann Gifford
Tim Vogel
Tim Manns