Working Waterfronts and Mudflat Habitat:

Addressing Marine-Based Livelihoods in Frenchman Bay

Frenchman Bay Partners

Prepared by

Emma Fox

Environmental Educator

Maine Conservation Corps/AmeriCorps Program

Mount Desert Island Biological Laboratory

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Acknowledgements

Thank you to Bridie McGreavy for her guidance and encouragement during the course of this project and Jane Disney for her constant support. I would also like to acknowledge Hannah Annis and Heidi Bray from the Maine Department of Marine Resources, both of whom were very helpful in my search for quantitative data. Thanks to Barbara Arter and Kevin Athearn for their advice, assistance, and willingness to be interviewed. Special thanks also to the Frenchman Bay Partners who participated in key stakeholder interviews.

Table of Contents

1. Prologue

After six months of AmeriCorps service with the Community Environmental Health Lab at the MDI Biological Lab and an audited course on Ecological Economics at College of the Atlantic, I wanted to perform a full ecosystem services valuation for Frenchman Bay. I had just begun my work with the Frenchman Bay Partners (a consortium of stakeholders around Frenchman Bay, including municipalities, research institutions, fishermen, schools, landowners, kayak companies, and land trusts), and wanted to contribute to their projects in some way, so a full ecosystem services valuation seemed like a good use of my new knowledge of Ecological Economics.

As I began my research process, I learned very quickly that my initial plan was overambitious. A full ecosystem services valuation for Frenchman Bay could be a Master's thesis project. Needing to scale back my focus, I chose only one of four conservation targets: mudflats. I continued to work with the Frenchman Bay Partners during my second sixth months of AmeriCorps service planning events, coordinating Partner communications, and documenting the stakeholder and conservation action planning process for the Partners. I gained more experience with the Partners and I delved into the literature. I considered my reading and transcripts from various Partner meetings (I was typing full real-transcriptions at this point), and decided that I needed to address working waterfronts and marine-based livelihoods in mudflats project.

After a few months of working with the Partners, I started to notice the difference between "conservation targets" and "human welfare targets" described in the Open Standards for the Practice of Conservation (CMP, 2007). The difference became obvious to me at the goal-setting session in November, 2012. I frequently heard the Partners talk about economic resilience, but it seemed to me that the focus in the viability assessment for the conservation targets (at the goal-setting session) was on ecological indicators rather than economic ones. In fact, economic indicators were left out of the viability assessment process altogether. This was where I felt I could start to address what I perceived as a need. I had heard that Dr. Kevin Athearn, from University of Maine Machias, had recently done studies on pollution closures and their impact on clam harvester sales. I called Dr. Athearn for advice about my project, and quickly realized that I would again have to scale back my study—I could request landings data and clam survey results from the Maine Department of Marine Resources, data that already existed, but to collect my own quantitative data at that point in time was simply unrealistic.

Finally, having focused the scope of my research, I started my analysis. The 610 Project grant was submitted with graphs I produced, along with text describing my calculations. I found the timing of the 610 Project fortuitous, because the Frenchman Bay Partners and the Regional

Shellfish Committee received the grant just as I was wrapping up the text for my report. With guidance from Jane Disney and Bridie McGreavy, I reconfigured the discussion section of this report to include a subsection highlighting the 610 Project as the first successful attempt made by the Frenchman Bay Partners to directly address marine-based livelihoods and working waterfronts as they relate to one of the conservation targets. It is the first major project the Frenchman Bay Partners have undertaken which confronts head-on the issue of economic resilience in the Bay, rather than as a by-product of ecological resilience.

Please understand that this report was created in an attempt to describe how the Frenchman Bay Partners are currently addressing marine-based livelihoods and working waterfronts and to provide recommendations for the Partners as they continue addressing this target in the future. This report includes a preliminary attempt at a market-based ecosystem valuation, using the data which was available to me at the time, and a rudimentary evaluation, based on a technical report for the University of Maine Machias (Athearn, 2008), of potential losses in harvester sales incurred from pollution closures in Frenchman Bay. My calculations should not be used for any purpose outside of this report—they are based on data which I did not personally collect, which were outdated, or which were intended for another study.

--Emma Fox, June 2013

2. Introduction

a. Purpose of this report

The purpose of this report is to demonstrate the connection between the economics and the ecology of intertidal mudflats in Frenchman Bay. This report is a socio-ecological economic case study on the interaction between user groups, resources, and how the interaction impacts the economy. First, the Frenchman Bay watershed region and local shellfish ordinance will be described in order to provide some background on this study. Second, the methodology will be discussed so that the Frenchman Bay Partners may repeat and build off of this study. Third, the trends in the quantitative data will be analyzed. Fourth and finally, the qualitative data from a literature review and key stakeholder interviews will be discussed at length, along with recommendations for future studies.

For reference, the Appendix A at the end of this report provides a glossary of terms.

b. The Frenchman Bay Watershed—a piece of Hancock County

Frenchman Bay is located in Hancock County and is bordered by the following 9 towns: Bar Harbor, Trenton, Lamoine, Hancock, Sullivan, Gouldsboro, Sorrento, Franklin, and Winter Harbor. Although it has no waterfront there, the City of Ellsworth is also included in the Frenchman Bay watershed. Eastern Bay and Taunton Bay, respectively, demarcate the southwestern and northeastern peripheral boundaries of the bay. Between these peripheries, four rivers empty into the bay: Taunton River, Skillings River, Jordan River, and Northeast Creek. Frenchman Bay is a natural resource upon which all of the towns, businesses, and individuals in the watershed depend in many alternative forms. General economic data for the Hancock County natural resources sector will be discussed in the analysis section on page 11.

Frenchman Bay is home to several of Maine's most important commercial shellfish species, such as soft-shelled clams (*Mya arenaria*). I will focus this report on the economic impacts of wild harvested soft-shell clams because of their importance to the Hancock County natural resources sector.

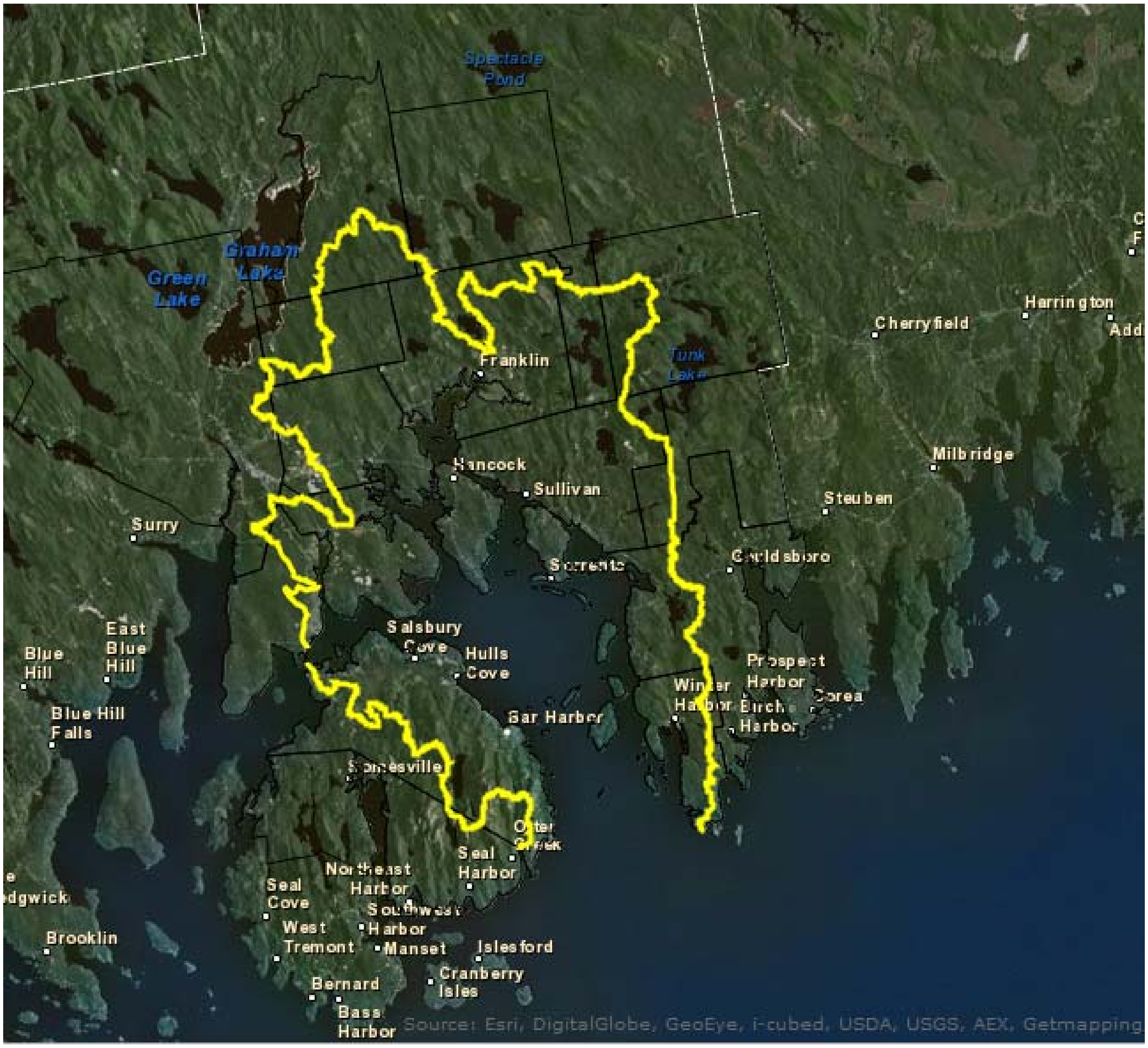


Image 1. Hancock County and the Frenchman Bay watershed outer boundary, indicated by the yellow border (source: Frenchman Bay Atlas, interactive online version 1.2).

c. Frenchman Bay Regional Shellfish Program

Soft-shell clams are a unique natural resource in Maine because they are one of the few marine resources that municipalities have the authority to manage. Of the towns bordering the water (including Ellsworth, whose fishermen use Frenchman Bay), all except for Bar Harbor, Gouldsboro, and Winter Harbor, are part of a seven-town Frenchman Bay Regional Shellfish Ordinance—one of only two multi-jurisdictional shellfish ordinances in Maine.

The Frenchman Bay Regional Shellfish Ordinance was instituted in 2010 after local harvester livelihoods were affected by intensive harvesting in Frenchman Bay in 2009 during a time of gulf-wide red-tide closures. The ordinance describes the Frenchman Bay Regional Shellfish Program, which is organized through both the Frenchman Bay Regional Shellfish Municipal Joint Board and the Frenchman Bay Regional Shellfish Committee.

Bar Harbor, Gouldsboro, and Winter Harbor each have individual municipal shellfish ordinances, and will not be discussed at length here.

i. Frenchman Bay Regional Shellfish Committee

As of 2012, the Frenchman Bay Regional Shellfish Committee (hereafter Shellfish Committee) represents 278 commercially and recreationally licensed clam harvesters from the seven towns covered in the ordinance: Ellsworth, Franklin, Hancock, Lamoine, Sorrento, Sullivan, and Trenton. The mission statement of the Shellfish Committee is to ensure that the seven towns act collaboratively to maintain, protect, manage and enhance the shellfish resources and ecological well-being of the Frenchman Bay Region, as well as to ensure the sustainable harvest of shellfish and economic opportunity for those who make their living on the tide.

Each license requires the completion of a set number of conservation hours, including beach clean-ups and/or resource management activities such as reseeding clam flats, performing clam flat surveys to inform conservation closure decisions, and brushing to encourage natural seed set in the mudflats (Quinby and Petersen, 2007).

d. Holistic and adaptive bay management: Frenchman Bay Partners

The Frenchman Bay Partners is a grassroots consortium of stakeholders (local businesses, organizations, institutions, municipalities, and individuals) working toward a sustainable future for Frenchman Bay, so that everyone may continue to enjoy and benefit from its resources. The Frenchman Bay Partners utilizes an innovative adaptive management technique called Conservation Action Planning, described in the Conservation Measures Partnership Open Standards for the Practice of Conservation (CMP, 2007). The Frenchman Bay Partners have identified four habitats and species of concern in their conservation action plan: eelgrass, benthic habitats, diadromous fishes, and mudflats. Though the focus of this paper is on mudflats habitat, the other three habitats and species of concern have economic value associated with each of them—the scope of my research did not allow for extensive analysis on the limited economic data available on each of the other three habitats and species of concern. I will address my recommendations for incorporating the other habitats and species of concern in the discussion section of this report on page 21.

In the process of setting and accomplishing goals based around the aforementioned habitats and species of concern, the Frenchman Bay Partners have been building a broad base of stakeholder engagement—in effect, they have been cultivating social capital (see Appendix A). Social capital is something the Regional Shellfish Committee has in relative abundance. The group is mostly made up of born-and-raised Maine clam harvesters making their living on the tide. Those in the committee who are “from away” and have since moved to Maine to establish their families and means of earning their livelihoods, have since assimilated and incorporated themselves into the working waterfront community to such an extent that they are part of the fiber which holds the Regional Shellfish Committee together. The connection between the Regional Shellfish Committee and the Frenchman Bay Partners has been crucial in garnering interest from other stakeholders such as municipalities and marine industry representatives.

The Partners have held two major collaborative capacity building sessions to date, in which different resource user groups have gotten together to discuss resource use and diffuse conflicts of interest around those resources. The Frenchman Bay Partners helped facilitate conversation between mussel harvesters, clam harvesters, and worm harvesters around the creation of a mussel plan by the Regional Shellfish Committee in their efforts to better manage the local soft-shell clam resource at a meeting in May, 2012. The Frenchman Bay Partners’ approach is to act as a kind of civil society platform on which various groups meet as equals and address issues in a way that does not require legislative or top-down intervention (http://www.frenchmanbaypartners.org/about/).

The Partners recently received a grant from the Maine Community Foundation for the Regional Shellfish Committee to build capacity toward undertaking a watershed survey, in an effort to accomplish the shared goal of opening all 610 acres of restricted clam flats in Frenchman Bay by 2017. Though the goal is based on the mudflats conservation target, it concerns the marine-based livelihoods which depend on the resource mudflats provide. The capacity building project is entitled the "610 Project," in reference to the aforementioned goal of trying to get all 610 acres of restricted clam flats in Frenchman Bay opened in the next five years. The $7,500 grant will build organizational capacity within the Regional Shellfish Committee. Additionally, an advisory board of Frenchman Bay Partners will help the committee work toward conducting watershed surveys to identify and remediate pollution in prioritized clam flats. Watershed surveys will require funding above and beyond the initial grant and will help identify the sources of pollution, so that the Regional Shellfish Committee and the larger Frenchman Bay Partners group can work together to clean it up and reap the economic benefits of additional open clam flat acreage.

e. Why look at resource economics and soft-shell clams?

So why look at resource economics as it relates to soft-shell clams? Based on interviews with key stakeholders of the Frenchman Bay Partners (including executive committee members, local municipal officials and mussel and clam harvesters) working waterfronts are one of the most frequently mentioned economic assets of Frenchman Bay. As a part of the adaptive management framework, the Frenchman Bay Partners have identified working waterfronts and marine based livelihoods as a target in their conservation action plan. The term 'working waterfronts,' according to the qualitative data from stakeholder interviews, encompasses the broader marine-based livelihoods, as well as the issue of waterfront access. This report will use both terms in tandem and will refer to the two as a single target. Incorporation of this target is becoming a greater part of the discourse around conservation action planning as the Frenchman Bay Partners move into the practical stages of adaptive bay management. The Partners, despite their success in incorporating marine-based livelihoods and working waterfronts into every step of the conservation action planning process, have been challenged to integrate the topic as a target in their bay management plan.

This report will directly address the working waterfronts target and establish an explicit and quantitative connection between it and the mudflats conservation target, based on the data available. This report will describe and estimate of the value of the most recently surveyed clam flats using landings data and the Market Price Method, as well as the potential losses incurred in restricted closure areas due to bacterial pollution using the Benefit Transfer Method, based on numbers from a technical report from the University of Maine at Machias (Athearn, 2008). This report will describe the projected relationship between clam sales and long-term bacterial pollution closures in Frenchman Bay based on the Benefits Transfer Method. Closure classification information is described in detail in Appendix A, along with the Benefit Transfer Method. Using the Market Price and Benefit Transfer valuations, this report will make recommendations about economic data gathering for each of the other conservation targets.

3. Methods

a. Quantitative research & data access

Requests for Frenchman Bay soft-shell clam (*Mya arenaria*) data were made to Heidi Bray, of the Maine Department of Marine Resources (MDMR), as well as blue mussel (*Mytilus edulis*) landings data for all ports in Hancock County from 2008 through 2011. For confidentiality purposes, the MDMR was only able to provide combined raw data from towns in the Frenchman Bay watershed, as well as the combined raw data from various months. At the time of my request, MDMR data for 2012 were unavailable.

The number of live pounds landed and the value of pounds landed were combined for all ports and the sum totals were analyzed on a month-to-month basis for soft-shell clams (page 13). The monthly values of pounds landed were divided by the monthly live pounds landed in order to calculate the monthly average value per pound of soft-shell clams. This calculation was also performed on a year-by-year basis to demonstrate the shift in the average value per pound over time. The lowest and highest values per pound landed were compared with the average on a year-by-year basis in order to show the range of variation in value over time (page 15).

Soft-shell clam survey data from clam flats in Frenchman Bay was requested from Hannah Annis, of the MDMR. Hannah provided clam survey data from 2004 through 2012 for the following towns: Gouldsboro, Lamoine, Hancock, and Trenton.

Using the MDMR soft-shell clam survey data and the average value per pound calculated from the raw soft-shell clam landings data, Market-Based Approach to Ecosystem Valuation calculations were performed for each of the most recently surveyed clam flat areas. These calculations were performed on a per acre value, by multiplying the average dollar value by the productivity of the clam flat. The calcualtions were also performed for the total acreage for the same clam flats, by multiplying the total standing crop greater than two inches by the total acreage for that particular clam flat. As the Market-Based Approach to Ecosystem Valuation here does not take into account multiple harvestable species the non-market goods and services provided by the ecosystem, it should be considered as a partial baseline value. The Market-Based Approach to Ecosystem Valuation is described in detail in Appendix A.

MDMR clam flat closure acreage data, in addition to numbers from a University of Maine Machias technical report on *Economic Losses from Closure of Shellfish Harvesting Areas in Maine* (Athearn, 2008), was used to calcuate loss estimates for the shellfish closure areas in Frenchman Bay. Athearn provides a potential losses range of $288 to $14,400 per acre, so each number was multiplied by the closure acreage for each clam flat to get an estimate of losses in each area. This Benefit Transfer Method estimate for losses is based on values for Machias Bay and should be used only for scoping in Frenchman Bay as it is not an accurate representation of the losses in this area. The Benefit Transfer Method is discussed in detail in Appendix A.

Glossary, tables, and maps can be found in Appendices A, B, and C, respectively.

b. Key stakeholder interviews

In order to perform key stakeholder interviews, the author of this report performed an online Human Subjects Research training provided through the University of Maine. The author of this report recorded real-time transcripts during interviews with 4 key stakeholders co-performed with Bridie McGreavy (Ph.D. candidate in the Communication and Journalism Department at the University of Maine) as a part of her dissertation research. The author developed economics-based questions for the interviews, which Bridie submitted to the Internal Review Board for review. The key stakeholders interviewed represent a diverse cross-section of the Frenchman Bay Partners group.

The qualitative data were analyzed for the purposes of this report. No direct quotations were taken from interviews, and the individual interviewees are not mentioned in this report. Only general trends from the qualitative interview data are desribed here. Interview questions are included in the Appendix D.

c. Literature review

The author sifted through technical reports on clam flat management and ecosystem valuation as well as academic articles on social capital and ecological economics in order to gain a more informed understanding of the connection between humans and natural resources. The full list of literature reviewed, including summaries of each source can be found in Appendix E.

4. Analysis

a. General economic information for Hancock County

To frame the socioeconomic analysis of the shellfish resource in the Frenchman Bay region, it is important to first describe the general economic status in Hancock County, particularly in the natural resources and mining sector (www.oceaneconomics.org). There was a generally decreasing trend for the gross domestic product (GDP), which is the total value for all final market goods and services produced in an area in a year, for the combined natural resources and mining economic sector for Hancock County, except for a positive spike in 2000, between

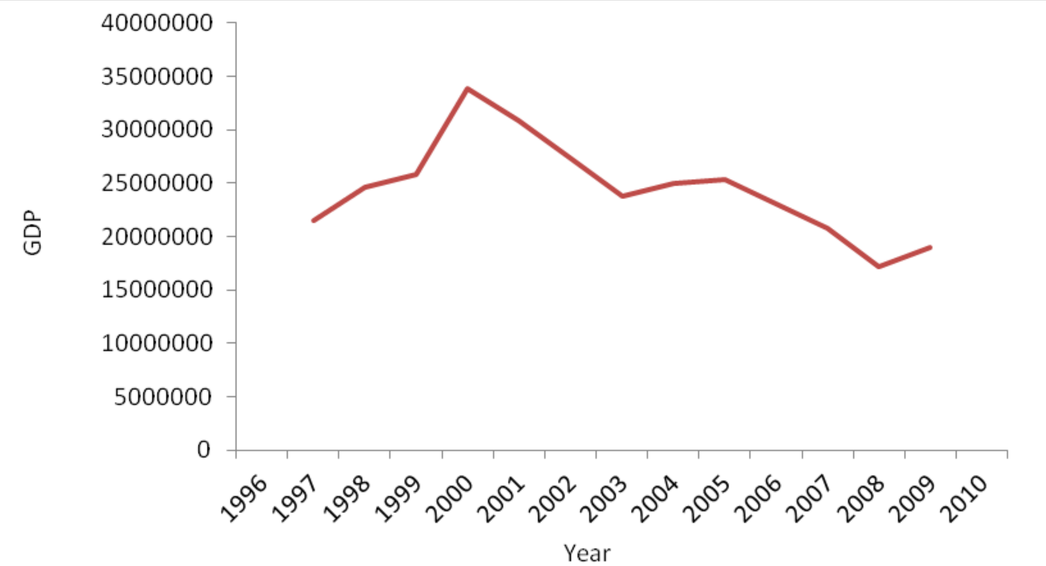


Figure 1. GDP for the combined nautral resources and mining economic sector for Hancock County from 1997 to 2009. Data unavailable for 1996 and 2010 (created with data from oceaneconomics.org).

the years 1997 and 2003 (Figure 1).

It is difficult to surmise the piece of the natural resources and mining sector which may have caused the spike in GDP for the year 2000, as the natural resources and mining sector includes the following industries: mining and oil extraction, agriculture, forestry, and fishing, amongst others. The same is true for the employment graph (Figure 2).

Between 2008 and 2011, Hancock County had the second highest number of active commercial harvesters by county in the state of Maine (MDMR, 2012); however, there was a general downward trend for employment in the combined natural resources and mining economic

Figure 2. Employment in the combined natural resources and mining economic sector for Hancock County from 1996 to 2010 (created with data from oceaneconomics.org).

sector for Hancock County from 1996 to 2010 (Figure 2).

Figure 3 shows the general increasing trend of the number of establishments in Hancock County representing the combined natural resources and mining economic sector from 1996 to 2010. Note the contrast between the positive relationship between the number of establishments each year and the negative relationships between GDP and employment each year in the natural resources and mining sector. GDP is often a poor representation of economic well-being because it does not take into account the harvesting or processing stages, only the final market goods and services, and thus ignores a great swath of the natural resources and mining sector. This numerical oversight, intrinsic to GDP, may account for the difference in trends in Figures 1 and 3.

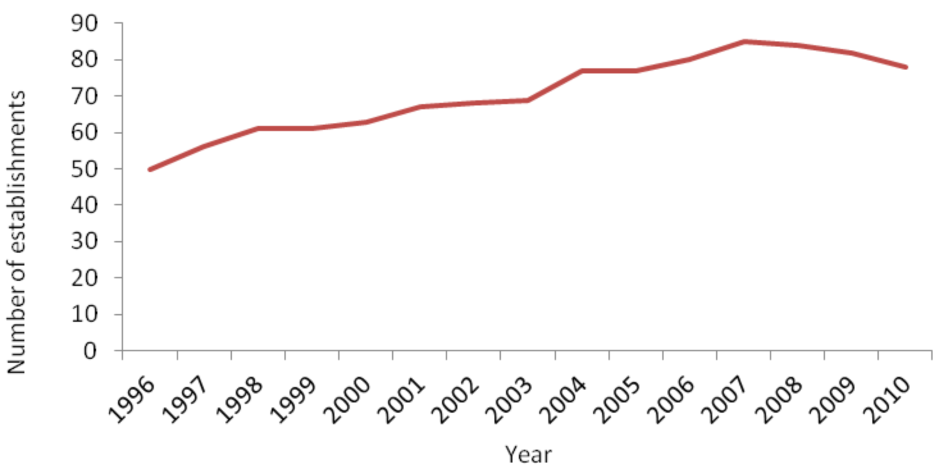


Figure 3. Number of establishments in Hancock County representing the combined natural resources and mining economic sector from 1996 to 2010 (from oceaneconomics.org).

These general trends for the natural resources and mining economics sector will act as a backdrop for the rest of the analysis in this report.

b. Soft-shell clam landings

The soft-shell clam landings analysis includes landings from ports in Frenchman Bay watershed towns. The towns of Bar Harbor and Gouldsboro, each with their own municipal shellfish ordinance apart from that of the seven town Frenchman Bay Regional Shellfish Ordinance, are included because both municipalities have waterfront on Frenchman Bay and are Frenchman Bay Partners. Ellsworth is also included in the landings data though it shares no waterfront with Frenchman Bay (Ellsworth waterfront is technically in Blue Hill Bay). It is a member of the seven town Frenchman Bay Regional Shellfish Ordinance and is signed on as a Frenchman Bay Partner. Many Ellsworth clam harvesters work the tides in Frenchman Bay.

There appears to be a direct relationship between sum of live pounds landed and the sum of landings values for all ports in Frenchman Bay; the sum of live pounds landed for soft-shell clams in the years 2008 through 2011 tends to peak in the summer months when the value per pound is highest (Figure 4). It is not clear from these data the nature of the relationship between the pounds landed and the value of pounds landed—the discrepancy between the sum of live pounds landed and sum of landings value peaks suggest that the relationship is not

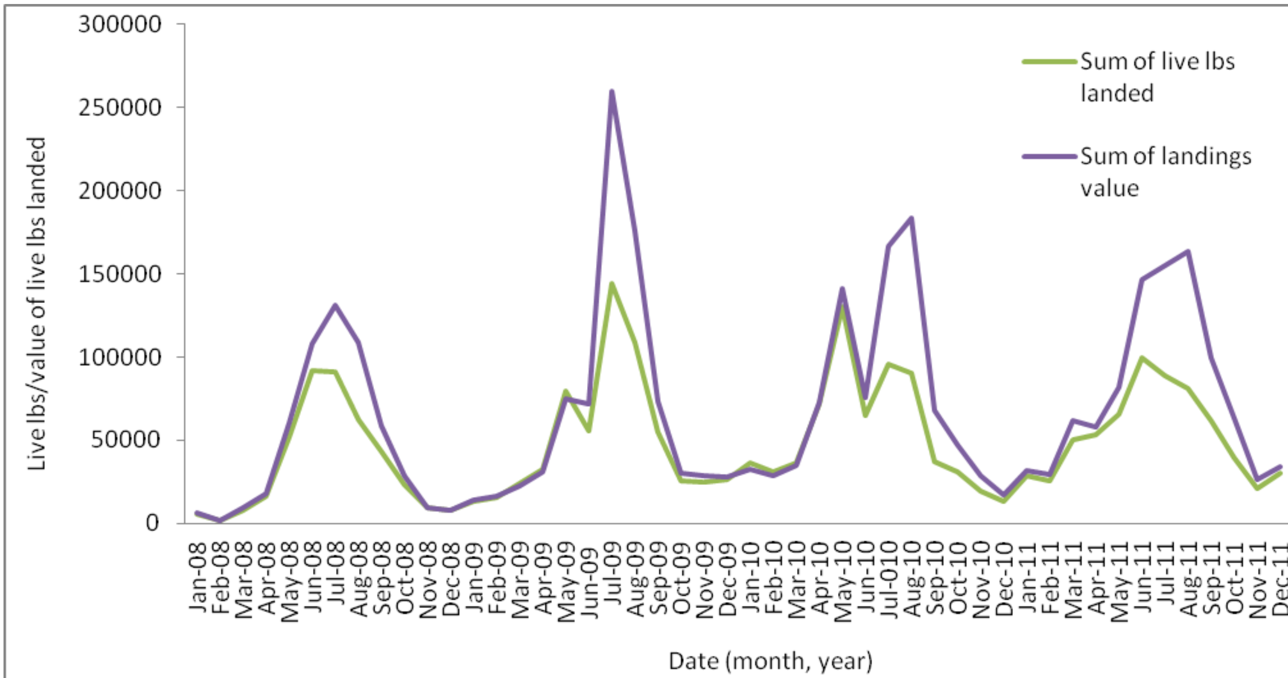


Figure 4. Softshell clam landings (live lbs) and corresponding landings value by year from 2008-2011 for all ports in Frenchman Bay combined, including Gouldsboro (MDMR, 2012).

simply one of cause-and-effect.

The average value per pound in the Frenchman Bay watershed region also appears to cycle seasonally from 2008 to 2011 (Figure 5). The dates with peaks in average value per pound are largely overlapping with the dates with peaks in landings value and live pounds landed. The corresponding peaks in the monthly average value per pound and the number of live pounds landed occur during the summer months, from May to September, which in coastal Maine means tourist season. The influx of tourists in coastal Maine increases the demand for soft-shell clams, which drives the price of soft-shell clams up dramatically, encouraging harvesters to harvest more soft-shell clams.

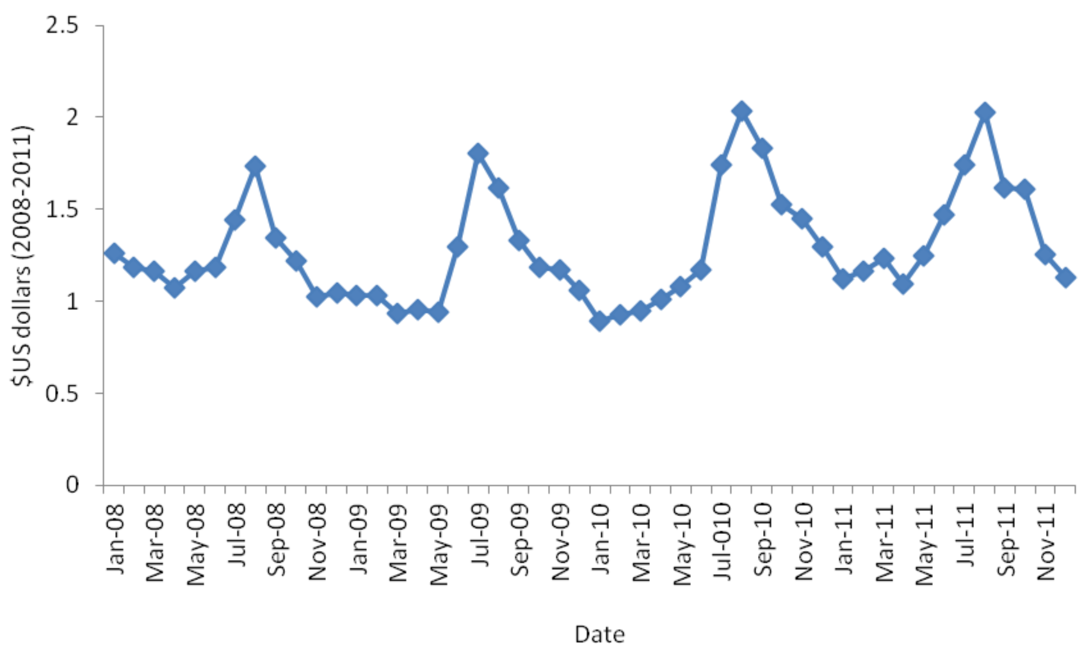


Figure 5. Monthly average value per lb of softshell clams landed from 2008-2011 for all Frenchman Bay ports, including Gouldsboro (MDMR, 2012)

In the annual cycle, August is the month in which the value per pound for soft-shell clams peaks, $1.85 on average from 2008 to 2011. The average value per pound for soft-shell clams is depicted on a yearly basis in table 1. The average value per pound landed, is calculated by dividing the total number of live pounds landed for that year by the total value of pounds landed. The wild harvested mussel values are included in table 1 as a comparison. The combined totals for each year in live pounds landed and value of pounds landed are included to demonstrate the greater overall value of mudflats when multiple species are considered. The combined total value of pounds landed for clams and mussels in 2011 was $1,681,289.82 for ports in Frenchman Bay alone (Table 1). Mudflats are a multi-million dollar natural resource in the state of Maine, *based only on market value*. The ecosystem valuation of mudflats will be discussed in the next section.

Species	Year	Total live lbs landed	Total value lbs landed	Average value per lb landed
MUSSELS	2008	573599	$288,167.00	$0.50
	2009	1227052	$515,335.55	$0.42
	2010	1180149	$780,355.25	$0.66
	2011	1127642	$729,423.77	$0.65
CLAMS	2008	412600	$549,041.08	$1.33
	2009	605948	$826,527.10	$1.36
	2010	658071	$896,316.98	$1.36
	2011	644298	$951,866.05	$1.48
TOTAL	2008	986200	$837,208.08	
	2009	1833000	$1,341,862.65	
	2010	1838220	$1,676,672.23	
	2011	2965861	$1,681,289.82	

Table 1. Total live pounds landed and average value per pound for mussels and soft-shell clams from 2008-2011. Data courtesy of Maine Department of Marine Resources, 2012.

Table 2 depicts the range of fluctuation for the average landings value per pound of soft-shell clams in Frenchman Bay between 2008 and 2011. There is a generally increasing trend in the overall market value when compared across years, with the greatest market values observed in 2011.

Average Market Value (US$/lb)	Low Market Value (US$/lb)	High Market Value (US$/lb)	Year
$1.33	$1.02	$1.73	2008
$1.36	$0.94	$1.80	2009
$1.36	$0.89	$2.03	2010
$1.48	$1.10	$2.03	2011

Table 2. Average, low, and high average market value in $US per pound of soft-shell clams landed in all ports in Frenchman Bay from 2008-2011, with values based on average, low, and high monthly average soft-shell clam landings each year. The initial average values are calculated from MDMR landings totals for ports in Frenchman Bay: the sum of landings value divided by the sum of live lbs for each month.

c. Ecosystem valuation

Ecosystem valuation is a process by which ecosystem services are broken down and assigned dollar values in order to easily calculate the economic value of the non-market goods and services provided by the ecosystem in question (Appendix A). Ecosystem services are goods and services provided by an ecosystem which may not necessarily have a market value. For instance, trees provide many services for a forested hillside, including (but not limited to) erosion prevention and oxygen production, besides wood for construction or heat production. Ecosystem valuation makes readily understandable the abstract or indirect benefits of conservation or restoration.

Below is an example of a highly simplified ecosystem valuation calculation for Partridge Cove, made with clam census survey and landings value data from the MDMR. Partridge Cove, in the Town of Lamoine, ME, is one of the clam flat pollution closure areas in Frenchman Bay. The total value of the soft-shell resource in Partridge Cove, achieved by multiplying the total standing crop by the average value per pound of soft-shell clams, is rather astounding and probably a high-end estimate. It is important to note that in this example, the total standing crop is an estimate, and the per-acre value, as well as the total value, are simple projections based on that estimate. It is also important to note that this value for Partridge Cove is based on a single species—it does not include blue mussels, worms, or any other species of commercial value which makes its home on the mudflat. This value also does not include the non-market goods and services provided by the mudflat habitat.

Total standing crop clams >2" in Partridge Cove (lbs)	**total acres surveyed**	**average US$/lb in 2011**	**On average, US$/acre**	**Value of Partridge Cove**
132550	4	$1.43	**$4,934**	$189,546.50

Table 3. Values for a simple ecosystem valuation calculation for the Partridge Cove clam flat, based on the standing crop of soft-shell clams greater than two inches in length. The standing crop value and survey acreage are from a 2012 MDMR survey of Partridge Cove in Lamoine, ME.

If one were to consider all of these other variables, the value of Partridge Cove would be very high indeed, all things considered. Table 3 most closely represents the Market-Based Ecosystem Valuation Approach (www.ecosystemvaluation.org, Appendix A), and should be considered a partial baseline. What this means for other studies is that any other ecosystem valuation attempt will produce a *much* higher value for Partridge Cove and every other clam flat in Frenchman Bay.

Figure 6 (below), with values also calculated using a Market-Based Ecosystem Valuation Approach, depicts the per acre dollar value and the total dollar value for all recently surveyed areas in Frenchman Bay. These numbers are based on total standing crop of soft-shell clams greater than two inches in length. The areas with very high total values have either higher productivities (average number of clams per acre) or are much larger mudflat areas than the others. Table 5, with the data behind Figure 6, can be found in Appendix C; it provides a clear idea of the productivity for each clam flat.

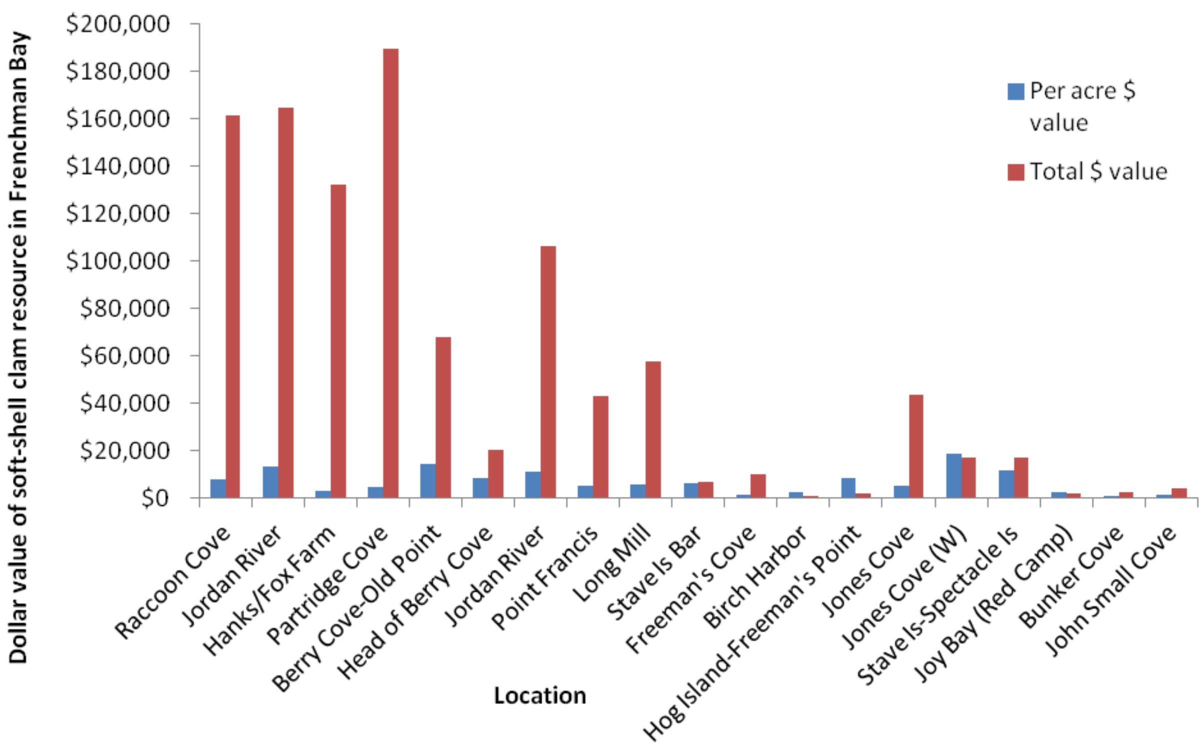


Figure 6. Soft-shell clam dollar value (total and per acre) for selected closed mudflat areas in Frenchman Bay, based on MDMR clam census survey data from 2004-2012. Average dollars/pound value is based on MDMR landings data from 2008-2011. All dollar

The per acre value is a projection based on productivity (average total pounds per acre), while the total value is based on total standing crop greater than two inches. In order to calculate the per acre value, the average dollar value for 2011 ($1.43) is multiplied by the productivity of the clam flat (average total pounds per acre). In order to calculate the total value, the total standing crop is multiplied by the same average dollar value for 2011.

A losses in harvester sales calculation was made based on estimates for Machias Bay from a technical report for the University of Maine at Machias (Athearn, 2008) using the Benefit Transfer Method for valuation. There are pros and cons to using the Benefit Transfer Method. It is a good method to get the scope of the ecosystem services valuation without doing all of the work, or without all of the necessary data. The Benefit Transfer Method is good in the case of little data, because it helps to highlight the gaps or missing pieces in the data. However, the Benefit Transfer Method is only as reliable as the initial study—it could be somewhat inaccurate if the location of the initial study and the site of interest are not similar.

For the purpose of this report, the assumption is made that the variables in Frenchman Bay are similar enough to those in Machias Bay to be able to justify using Athearn's losses values for the Benefit Transfer Method. The values in this report are estimates based on Athearn's estimates. Athearn notes in his report (2008) that losses from long term clam flat closures are more difficult to address, due to the myriad of variables associated with such an estimate. He presents his calculations as rough figures to be used in estimating potential value for shellfish closure acreage; as such, the values described here should be taken with a whole teaspoon of salt.

Table 4 shows the high and low estimates for economic losses by acreage in each of the closed shellfish areas in Frenchman Bay. Descriptions of the closure classification types can be found in Appendix A. The high and low losses estimates are not only Benefit Transfer Method-based, but also unit transfer—the numbers are calculated using Athearn's per acreage annual loss estimates. Athearn calculated annual losses between $288 to $14,400 in harvester sales per acre in Machias Bay. The losses estimates in Table 4 are calculated by multiplying the acreage by either $288 or $14,400 to get the low or high end of the spectrum, respectively.

Closure Area Number	Closure Section	Name	Classification	Acreage	Low loss estimate (2008 $US)	High loss estimate (2008 $US)
42	A3	Northwest Cove	R	90	$25,920.00	$1,296,000.00
47	A1	Bar Hbr to Thrumcap	P	1106	$318,528.00	$15,926,400.00
47	A2	Bar Hbr to Hulls Cove	P	728	$209,664.00	$10,483,200.00
47	A3	Sand Pt to Levi Pt	P	132	$38,016.00	$1,900,800.00
47	A4	Salisbury Cove	P	14	$4,032.00	$201,600.00
47	A5	Trenton Airport	R	136	$39,168.00	$1,958,400.00
47	A6	Thomas Bay	R	34	$9,792.00	$489,600.00
47	B	Thomas Bay	CA	59	$16,992.00	$849,600.00
47	C	Bar Hbr Bar	CR	73	$21,024.00	$1,051,200.00
49	A	Jellison Cove	P	9	$2,592.00	$129,600.00
49	B	Carrying Place	R	88	$25,344.00	$1,267,200.00
49	B2	Kilkenny Cove	R	212	$61,056.00	$3,052,800.00
49	B3	Mud Creek	R	28	$8,064.00	$403,200.00
49	B4	Mill Cove Pond	R	22	$6,336.00	$316,800.00
		TOTAL	R	610	$175,680.00	$8,784,000.00
		TOTAL	P	1989	$572,832.00	$28,641,600.00
		TOTAL	CLOSED	2731	$786,528.00	$39,326,400.00

Table 4. A comparison of high and low loss estimates for annual harvester sales(in 2008 $US), based on estimates on per acreage losses for Machias Bay from a technical report for the University of Maine at Machias (Athearn, 2008). It should be noted that these values are direct unit transfers and are rough calculations only—*not to be used for anything outside of this report.* Classification refers to the type of closure, detailed in Appendix A. Yellow rows indicate restricted closures and red rows indicate prohibited closures.

The range of total losses in harvester sales per closure area classification varies greatly, but it offers some perspective on the economic impact of the closure areas. Even based on the lower estimate of losses in harvester sales, these values fail to take into account the total economic impact of the pollution closures to the local economy. Under the most controlled scenario, it may be possible to directly connect landings with clam flats open to harvest—this would mean that losses in open mudflat (closures) could lead to losses in landings. The scope of this study does not allow for such a controlled scenario.

The GIS map of shellfish closures from the Frenchman Bay Atlas (Brett, et al. 2012) depicts shellfish areas closed to harvest due to pollution (Figure 7). The map differentiates between soft-shell clam habitat and mudflat, but because the losses calculations focused on closure areas, the phrases are used interchangeably here. The closure acreage data acquired from the MDMR is based on ground-truth surveys of those areas (Table 4). There are discrepancies between the MDMR data and the data described by the attribute table for pollution closures in the Frenchman Bay Atlas map showing shellfish closure areas. These discrepancies will be addressed in the next version of the Frenchman Bay Atlas, at which point the attribute table data for pollution closures will be reconciled with actual MDMR numbers (ie. the shapefiles will match the data on file at the MDMR). The numerical discrepancies between Atlas data and MDMR data are addressed in the discussion section on page 27.

d. Stakeholder interview results: perceptions about mudflats and marine-based livelihoods

There is a general sense among the key Frenchman Bay Partners stakeholders interviewed that the group has yet to directly address working waterfronts and marine-based livelihoods as a target described in the Bay Plan (http://www.frenchmanbaypartners.org/publications/frenchman-bay-plan/). The feeling shared by most interviewees was that the Frenchman Bay Partners as a group has not yet begun to tackle economic resilience with specific strategies or goals. So far, most of the planning has been on the conservation side of resource management, from which the local economy benefits indirectly as a mid-to-long term byproduct of ecological resilience.

The group has not yet developed a more direct approach to actively increase economic resilience around Frenchman Bay, or set specific goals around working waterfronts and marine-based livelihoods as a target in the Bay Plan. Interview data suggests that discourse about conservation action planning has thus far revolved around the four conservation targets: mudflats, benthic habitats, diadromous fishes, and eelgrass. Each of the conservation targets is associated with multiple fisheries, so economics has by no means been left out of the discussion; rather, stakeholders seem to have different perceptions about the terminology suggested by the Conservation Measures Partnership in the Open Standards for the Practice of Conservation (CMP, 2007).

Open Standards terminology has been a recurring difficulty for the Frenchman Bay Partners in the conservation action planning process. It is difficult to get everyone up to speed with reminders about key ecological attributes, strategies, goals, and threats when trying to tackle the next stage in the planning process. Some confusion around the use of the term "target" as it relates to marine-based livelihoods persists among Partners. It may be a good idea for the Partners to have a planning meeting or goal setting session to discuss marine-based livelihoods more specifically as an official target in the Bay Plan. If the Partners ultimately decide to drop the “target” terminology, then they still need to determine the best means of addressing the marine-based livelihoods and working waterfronts as a target, even though the connection between ecological and economic resilience is always explicit in conversation.

Figure 8. This Wordle (www.wordle.com) depicts the common words from five key stakeholder interviews. Interviewees were asked questions about whether or not they believe the marine livelihoods target is being addressed and about their sense of the economic value of mudflats in Frenchman Bay.

Where mudflats are concerned, working waterfronts and marine-based livelihoods are tied directly to the productivity of the habitat. Ecological productivity of open clam flats directly benefits soft-shell clam harvester sales—with more clams available, there is more money being earned. There was a shared feeling from key stakeholders that mudflats are culturally, as well as commercially important to the area. Based on interview data, it might make sense for the Frenchman Bay Partners to attempt a series of “willingness to pay” surveys with different key stakeholder groups when trying to assess the other ecosystem services provided by mudflats outside of market value.

5. Discussion

a. Limitations

A major limitation in this study includes insufficient data on clam flat productivity. The clam census survey data in Frenchman Bay is not recent for all harvest areas, and entirely outdated for most restricted-closure areas. The values calculated for ecosystem valuations by acreage are extrapolated from clam census survey data collected by the MDMR from 2004-2012. As such, productivities for areas on which ecosystem valuations were performed are based on soft-shell clam landings data are unknown. Clam census surveys in closure areas prioritized by the Regional Shellfish Committee for the purposes of the 610 Project will be underway in the summer of 2013 for the seven towns under the Frenchman Bay Regional Ordinance.

The ecosystem valuation calculations for the present study are based on single species market price data only. To get a more complete idea of the economic value provided by the nonmarket goods and services produced by mudflats, the Frenchman Bay Partners should perform a complete ecosystem services valuation using either the Damage/Replacement Cost method, which estimates the cost of replacing or losing altogether the ecosystem services provided by the healthy, fully functioning ecosystem, or the Contingent Valuation Method, which estimates the value of the ecosystem based on consumer willingness to pay in hypothetical scenarios aimed at isolating the importance of ecosystem services perceived by individual consumers (www.ecosystemvaluation.org).

Additionally, the dollar values for the Market-Based Ecosystem Valuation of recently surveyed clam flats in Frenchman Bay are based on 2011 landings data—the values are in 2011 $US, not 2013 $US. The dollar values for the Benefit Transfer Ecosystem Valuation on losses due to pollution closures based on the University of Maine Machias technical report (Athearn, 2008) are in 2008 $US, because that was the year in which the report was published. The present study does not account for inflation or deflation from 2008 to 2011—due to the slowly changing economic climate Post-Recession, it can be assumed that there probably is not a dramatic difference in landings values.

Limitations to the Benefit Transfer Method of ecosystem valuation abound; however, based on the limited availability of data and the small time frame for data collection, it was the best method available. As such, these values should not be used for any other purpose than project scoping or initial advocacy for grant-writing purposes. Knowledge to action must be considered—these values are rough estimates of the value of the services rendered from the mudflats ecosystem and are based only on landings value.

These data also do not take into account the losses incurred by short-term red tide closures. Such closures are set in place in order to protect public health. Red tide closures can be as brief as a few days or as prolonged as a few weeks, causing losses in direct income for shellfish harvesters. However, because the MDMR has a well-advertised red-tide monitoring program with which the public is familiar, the industry may experience fewer losses as a whole, than if the public did not understand that shellfish sold in reputable restaurants is safe. Losses are losses nonetheless, and losses incurred by red-tide closures are not considered in my analysis.

'Cottage industries'—clam and mussel harvesters selling directly to the public, rather than through a processor—make shellfish markets more difficult to analyze as well, because the level of reporting is completely different (Athearn, 2008). The Maine Department of Marine Resources does not keep track of landings data from harvesters selling directly to the public.

b. Threats

Pollution from wastewater outflows is currently a threat to the mudflat health in Frenchman Bay. Several clam flats are prohibited or restricted to harvesting because of the public health hazard posed by the proximity of wastewater discharge or failing septic systems. Future projects, addressed in the next section, include watershed surveys to pinpoint point source and non-point source pollution (see Appendix A) in the general Taunton Bay and Upper Frenchman Bay regions.

Poaching was mentioned in key stakeholder interviews as a possible threat impacting several of the marine industries, and is one of the easier threats to address through self-policing policies within harvester groups and the development of informal agreements between user groups.

Ocean acidification and invasive species are the two greatest threats which face the shellfish harvesting community. Ocean acidification is not easily mitigated—it is a threat on a global scale and, as such, is difficult to address on a local level. Invasive species are also difficult to mitigate, especially in a marine environment.

All of the threats mentioned above are factors that need to be considered in a Damage or Replacement Cost ecosystem valuation (more in the discussion section on page 26).

c. Future Projects

i. The "610 Project"

The biggest upcoming project for the Frenchman Bay Partners is supporting the Regional Shellfish Committee with the 610 Project. The Regional Shellfish Committee recently received $7,500 from the Maine Community Foundation for building organizational capacity towards the goal of opening closed clam flats in Frenchman Bay. The number 610 represents the total acreage for clam flats in Frenchman Bay marked as restricted closures, open only to MDMR-approved depuration harvest (Appendix A). The goal of the project is to build the necessary organizational capacity within the Regional Shellfish Committee for identifying and remediating pollution in prioritized restricted closure areas. With the assistance of an advisory board of Frenchman Bay Partners with project-relevant expertise, the Regional Shellfish Committee will grow their social capital (Flora, C.B. and Flora, J.L. 1996) and work on institutional development.

The first phase of the 610 Project is for the advisory board to create a flow guide to opening mudflats closed to harvesting. The guide will identify the correct channels within the proper state government agencies, such as the Department of Marine Resources and the Department of Environmental Protection, and the people within those channels to contact for water quality testing and data, watershed surveys, and the current status of priority mudflat areas prioritized by the Regional Shellfish Committee. The advisory board has identified a clam harvester liaison to go between the board and the Regional Shellfish Committee and who will field test the flow guide once it is created.

The Frenchman Bay Regional Shellfish Committee has prioritized the following closures areas for pollution source identification and clean-up:

- Egypt Bay, Franklin: 50-B, A.1
- Martin Cove/Weir Cove, Lamoine: 49-B, A
- Kilkenny Cove, Hancock: 49-B, B.2
- Springer Creek (Dwelley Cove), Hancock: 50-B,A.4
- Trenton Airport, Trenton: 47, B.1
- Carrying Place Cove, Hancock: 49-B, B.1

Many of the priority areas listed above are either large, easily accessible to harvesters, or perceived to be highly productive areas.

ii. Update the shellfish closures map in the Frenchman Bay Atlas

The shellfish closures map in the Frenchman Bay Atlas can be used to determine the acreage of workable mudflat for both mussel and clam harvesters, based on DMR shellfish closure acreage data, habitat classification data, and wastewater outfall location data. Currently, the shellfish closure acreage data in the attribute table of the Frenchman Bay Atlas does not match up with the MDMR acreage data for shellfish closure areas. This map has the potential for multiple uses and would benefit from updates. For the purposes of ecosystem valuation, the acreage of workable mudflat should be determined for a Market Based Valuation method (see Recommendations on page 26).

d. Recommendations

A full ecosystem valuation is necessary for each of the conservation targets identified in the Frenchman Bay Plan if working waterfronts and marine-based livelihoods are to be directly addressed. Ecosystem valuation requires measurable environmental services, consistent definitions of economic value across projects and, of course, valid empirical methods. The Market Price Method (www.ecosystemvaluation.org) functions only as a preliminary screening method, and is not accurate enough to be truly representational of the value of closures areas, especially across the different habitats and species of concern for the Frenchman Bay Partners.

Other ecosystem services valuation efforts may be difficult to apply, due to the nature of the resources and the way the Partners have defined their targets. The diadromous fishes target, for instance, includes both freshwater and saltwater habitat, as well as highly commercially valuable juvenile members of the American eel species (elvers). The commercial value of elvers alone fluctuates by thousands of dollars per pound on a seasonal basis.

Assuming some level of difficulty in maintaining consistent evaluation across targets, it would be more appropriate to choose specific ecosystem services and place values on those with the data available, with the understanding that the values will likely be a gross underrepresentation when combined to calculate any sort of total ecosystem valuation for each of the targets. When placing values on ecosystem services, numbers will vary depending on the ecosystem structure and function—some ecosystems are just more complex than others. The number and different types of beneficiaries from each service varies greatly. The hardest part may be finding a way to count the values only once.

And though it is difficult, a dollar sign can be applied to aesthetic value as well, based on willingness to pay for, say, the picturesque sunset over Frenchman Bay or the idyllic lobster pot buoys scattered on its surface. Value does not have to be paid for to be worth something to someone.

Another study on an adaptive management framework similar to conservation action planning evaluate key sustainability variables such as (Magnuszewski, et al. 2008). While the conceptual models for the Magnuszewski, et al. study (2008) are certainly more thorough than anything the Frenchman Bay Partners have as of yet for the economics piece, the indicators selected for each key sustainability variable are complex. The Partners might consider creating conceptual models to address the marine-based livelihoods and working waterfronts piece in the Frenchman Bay Plan, but setting concrete strategies such as performing a complete ecosystem valuation, and setting goals such as opening 610 acres of restricted-closure mudflats are a more direct approach to addressing the economics piece.

Ultimately, the author recommends that the Partners hire a consultant, work with someone from the University of Maine, or invite a Partner to do a complete analysis on ecosystem services relating to each of the four habitats and species of concern using both the Market Price Method and the Damage or Replacement Cost Method where possible (Appendix A). The Partners would greatly benefit from such a complete ecosystem services valuation in their effort to better address the working waterfronts and marine-based livelihoods target.

Familiarity with the value of the ecosystem services provided by each of the targets in the conservation action plan will give the Partners more leverage when trying to engage new stakeholder groups, especially in the tourism and real estate markets. Weighing the cost of degrading natural products against the benefits of improving it or maintaining it at a healthy level is particularly pertinent for those markets, as so much property value depends on beauty, especially in coastal Maine.

As mentioned earlier, in using the conservation action planning process the Frenchman Bay Partners have successfully integrated the concepts of ecological and economic resilience in conversation, but they have been challenged to do so in practice. Part of the problem lies with the terminology prescribed by the Conservation Measures Partnership's Open Standards for the Practice of Conservation; it is often confusing and full of jargon (Schwartz, et al. 2012). Much of the terminology described in the Open Standards has helped push the conservation action planning process more toward discussion of the conservation targets, with marine-based livelihoods and working waterfronts as a secondary and implicit benefactor of ecological monitoring, restoration, or improvement.

The 610 Project is the exception to this observation—the Frenchman Bay Partners and the Regional Shellfish Committee have together identified an economic goal, opening 610 acres of restricted closure clam flats to harvesting, and have begun addressing a series of strategies to achieve that goal. With $7,500 from the Maine Community Foundation for building capacity in the Regional Shellfish Committee, the advisory board will help the Regional Shellfish Committee improve organizational capacity and work toward a watershed survey to identify and eventually mitigate sources of pollution. Re-opening closed clam flats will be directly economically beneficial to harvesters—with more area to harvest from, harvesting will likely increase along with harvester sales. Re-opening clam flats will be a concrete step toward ensuring the economic resilience of Frenchman Bay.

If terminology is one barrier to directly addressing goals and strategies for supporting marine-based livelihoods and improving economic resilience in Frenchman Bay, access to relevant data is another. Insufficient data is the other part of the problem in connecting ecological and economic resilience in practice. The Frenchman Bay Partners need to coordinate an environmental services valuation and perform "willingness to pay" surveys for each of the conservation targets, pooling the data in a fashion similar to the Frenchman Bay Atlas.

Once the Frenchman Bay Partners reconcile the terminology confusion and perform a full ecosystem valuation on each of the targets, the next step would be to actually incorporate all of the economic information into data layers for a representative map in the Frenchman Bay Atlas. After the Partners have a means by which to visually direct their conversation about economic resilience, they will be better equipped to address strategies and goals relating to marine-based livelihoods and working waterfronts. Incorporating marine-based livelihoods and working waterfronts into the Frenchman Bay Plan will come next, followed ultimately by putting strategies into practice in order to help achieve specific goals.

To recap, this report described the importance of the soft-shell clam resource, discussed methodology, and pointed out trends in the landings data. The report presented a rudimentary ecosystem valuation for mudflats recently surveyed by the MDMR and provided an account of the losses both by acreage and per total area for each clam flat closed to harvesting due to pollution. Though the study has its limitations, the author's recommendations will hopefully be useful. If anything, the practice of assembling this report was a helpful gauge on what data is available to the Frenchman Bay Partners and in what form.

6. Epilogue

After a year as an AmeriCorps Environmental Educator working with the Frenchman Bay Partners, I finally feel that I am able to leave behind some sort of legacy. Working with the Frenchman Bay Partners, and particularly the act of researching and writing this report, has helped me develop professionally in ways I could not have possibly imagined. It is my hope that this document may serve as a helpful resource and reference as the Frenchman Bay Partners move forward with their conservation action planning process. The Frenchman Bay Partners may use this report however they see fit—as a public document on the website, as support for future grant proposals, or as a base for future study. I hope that my efforts here will help the Partners move forward and continue to integrate ecological and economic resilience in practice as well as in conversation.

7. Appendices

a. Appendix A: Glossary

Long term pollution closure classifications, based on MDMR water sampling:

1. **Prohibited**-No harvesting of any kind is allowed in prohibited areas.
2. **Restricted**-No harvesting of any kind except MDMR-approved depuration in restricted areas.
3. **Conditionally restricted**-Open to depuration harvesting, except for specific times or conditional periods during the year as specified by the MDMR.
4. **Conditionally approved**-Open, except for specific times or conditional periods during the year as specified by the MDMR.
5. **Approved**-Open to harvesting.
6. **Depuration**-Involves placing harvested shellfish into tanks or open areas of uncontaminated seawater, so that they may filter clean water and purge themselves of toxins or pollution, usually for a period of 48 hours or longer (MDMR website).
7. **Point source pollution**-Pollution coming from a specific source, like a sewer outfall or a combined sewage overflow.
8. **Non-point source pollution**-Often pollution from various inputs, often wild animal waste.

Other Terms:

1. **Gross Domestic Product**- sum of all final market goods and services for an area (often a whole country) for a set time frame (usually a year). GDP does not take into account unfinished or intermediate products and is considered an unreliable value for many economic sectors.
2. **Social capital**- reciprocity or trust between parties. Social capital is often elusive and is something that needs to be built up (Flora, C. and Flora, J. 1996)
3. **Institution**- framework.
4. **Ecosystem services**- non-market goods and services provided by an ecosystem. For example, though the product of trees is timber, the ecosystem goods and services include oxygen production, shade production, wind reduction, erosion prevention, and habitat provision. Dollar values can be placed on these ecosystem services through ecosystem valuation (www.ecosystemvaluation.org)

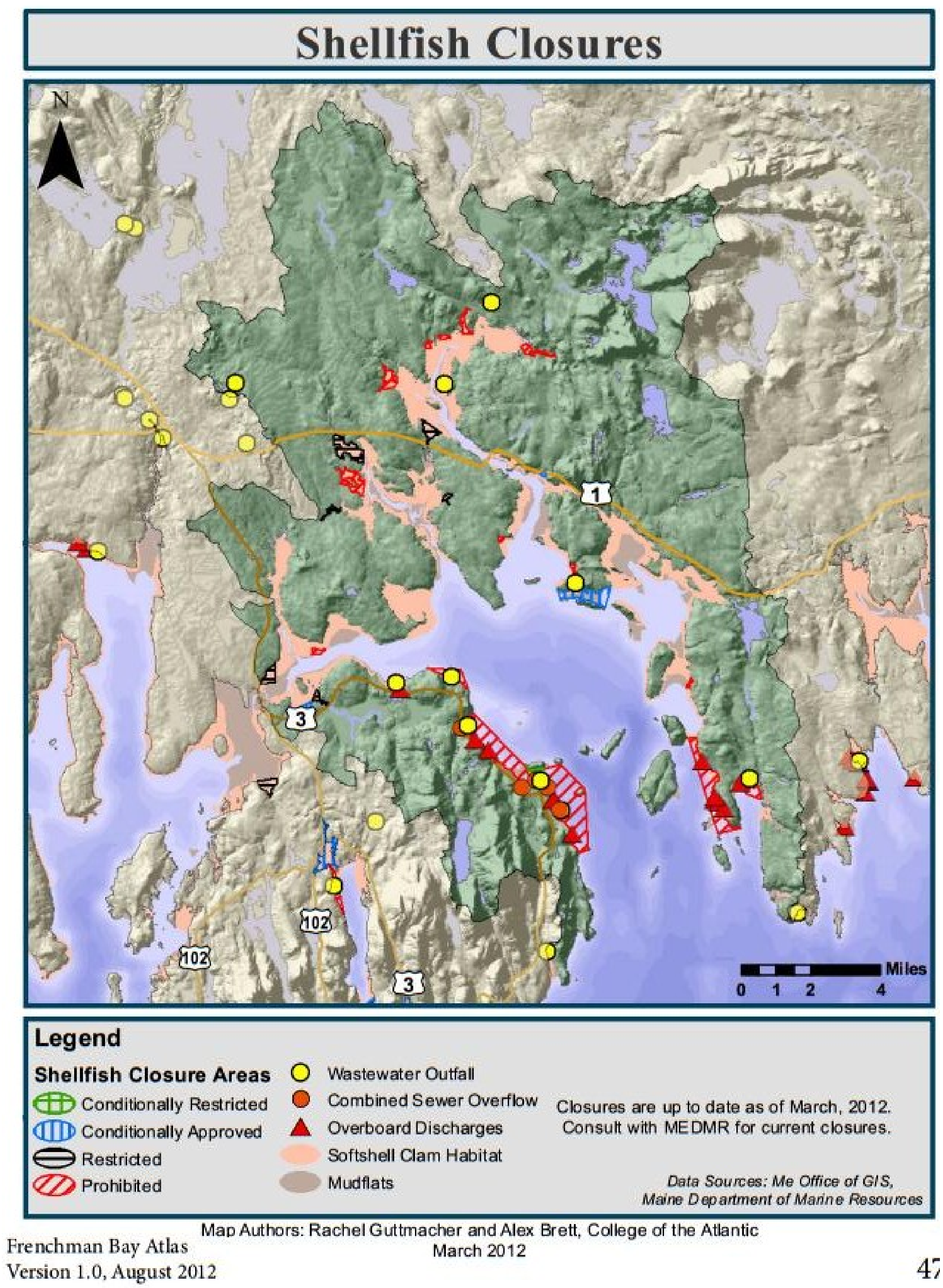
5. **Ecosystem valuation**- placing estimated dollar values on ecosystem services (described above), often based on "willingness to pay" scenarios. Ecosystem valuations can also be calculated using a Market Price, Benefit Transfer, Damage/Replacement Cost, or Contingent Valuation Method (www.ecosystemvaluation.org).
6. **Market Price Method**- using real market values to place a dollar value on an ecosystem on a per acre basis. This method does not take into account the non-market values of ecosystem services. It is often an underestimate (www.ecosystemvaluation.org).
7. **Benefit Transfer Method**-using another ecosystem valuation study as a basis or guide for the calculations in the present study. It is important to know that the Benefit Transfer Method is only as reliable as the original study. This method is often unreliable, because though the similarities between previous ecosystem valuation studies and the present study may be great, there are always slight differences (www.ecosystemvaluation.org).
8. **Damage/Replacement Cost Method**-using the cost of damage or replacement of ecosystem services to extrapolate the value of the ecosystem services(www.ecosystemvaluation.org).
9. **Contingent Valuation Method**-using both the use and non-use values to extrapolate the value of the ecosystem services (www.ecosystemvaluation.org).

b. Appendix B: Tables

Date Surveyed	Town	Area	Productivity (average total lbs/acre)	Total standing crop >2" (lbs)	Per acre $ value	Total $ value
Apr-12	Trenton	Raccoon Cove	5550	112,900	$7,937	$161,447
Apr-12	Trenton	Jordan River	9500	115,300	$13,585	$164,879
May-12	Hancock	Hanks/Fox Farm	2450	92,400	$3,504	$132,132
May-12	Lamoine	Partridge Cove	3450	132,550	$4,934	$189,547
Jun-12	Lamoine	Berry Cove-Old Point	10350	47,450	$14,801	$67,854
Jun-12	Lamoine	Head of Berry Cove	6200	14,200	$8,866	$20,306
Jun-12	Lamoine	Jordan River	7900	74,250	$11,297	$106,178
Feb-04	Gouldsboro	Point Francis	3950	30,400	$5,649	$43,472
Feb-04	Gouldsboro	Long Mill	4000	40,300	$5,720	$57,629
Jun-04	Gouldsboro	Stave Is Bar	4350	4,750	$6,221	$6,793
Jun-06	Gouldsboro	Freeman's Cove	1300	7,350	$1,859	$10,511
Dec-07	Gouldsboro	Birch Harbor	2000	850	$2,860	$1,216
Jul-07	Gouldsboro	Hog Island-Freeman's Point	6000	1,450	$8,580	$2,074
May-07	Gouldsboro	Jones Cove	3800	30,650	$5,434	$43,830
Sep-07	Gouldsboro	Jones Cove (W)	13250	12,150	$18,948	$17,375
Sep-07	Gouldsboro	Stave Is-Spectacle Is	8300	11,900	$11,869	$17,017
May-08	Gouldsboro	Joy Bay (Red Camp)	1700	1,450	$2,431	$2,074
May-08	Gouldsboro	Bunker Cove	650	1,750	$930	$2,503
Jun-08	Gouldsboro	John Small Cove	1150	2,900	$1,645	$4,147

Table 5. Data behind Figure 8 including survey dates, productivity (in average total lbs per acre), total standing crop greater than two inches (in pounds), as well as per acre dollar value and total dollar value (in 2011 $US), by closure area. The data for this table is based on MDMR clam census surveys from 2004-2012.

c. Appendix C: Map



7. GIS map of shellfish areas closed to harvest due to pollution (Frenchman Bay Atlas). Closure classification information can be found in Appendix A.

d. Appendix D: Interview Questions

The following are economic analysis questions formulated for five key Frenchman Bay Partners stakeholder interviews.

1. As you know, the Partners have identified working waterfronts as a focus in the conservation action plan. What do you think about how the Partners are addressing this target?
2. What is your understanding of the economic value of mudflats?
    a. Do you know of any resources that might be useful to us as we start to define our goals related to this target? For example, we are using DMR landings data as well as a report from UMaine Machias that has given us some useful information as a starting point to assess the impact of closed clam flats on the region's economy.
3. How do you think the economic benefits of the working waterfront (as it relates to you or your business) should be addressed?
    a. How about the ecological benefits of the working waterfront? What do you see as the relationship between the two? How could this relationship be improved?

e. Appendix D: Literature Summaries

i. **Athearn, K. (2008) Economic Impact of Maine's Shellfish Industry**

This technical article analyzes the magnitude of both direct and indirect impacts of the shellfish industry on Maine's economy. Indirect impacts are generated by local goods and services purchased to support shellfish harvesting—those include fuel and equipment and are measured in terms of local sales, income, and employment that derive from shellfish and related expenditures. Direct impacts are output and income from shellfish harvesting. For analysis purposes, Athearn divided Maine's shellfishing industry into four different sectors: 1. Clam digging, 2. Shellfish dragging, 3. Shellfish aquaculture, and 4. Shellfish markets.

Athearn looks specifically at soft-shell clams, mahogany quahogs, mussels, oysters, hard clams, and scallops, because while there is a market for gastropod species, harvest information was difficult to obtain. According to Athearn, indirect impacts alone from shellfish sales add up to $26.1 million dollars in output; however, it is important to note that this number was generated by taking aquaculture into account. Athearn used market channel analysis and a regional input-output modeling system to determine an estimate of total economic impact of the shellfish industry in Maine.

The report summarized harvesting techniques for soft-shell clams, and the landings data from 2001-2006. Soft-shell clams are the most valuable harvested shellfish, with prices peaking in the summer months. The report also summarized harvesting techniques for blue mussels, and the landings data from 2001-2006. Athearn claims that most of Maine's mussel catch is landed in Washington and Hancock Counties.

Athearn describes the various market channels through which Maine shellfish are sold; most often, shellfish are sold directly to a wholesale dealer by the harvester. The wholesale dealer either sells to other wholesale dealers in Maine, out-of-state dealers, or in-state restaurants and retailers. Most shellfish caught in Maine is sold outside of Maine. Athearn includes a useful diagram of the various market channels through which Maine shellfish are sold. Athearn identified four broad market channels in his analysis as well: 1. Live product sold wholesale to Maine restaurants and retailers, 2. Live product sold wholesale out of state, 3. Product shucked in Maine and sold wholesale to Maine restaurants and retailers, and 4. Product shucked in Maine and sold wholesale out of state. Athearn concludes that although the shellfish industry is declining, it is still important to Maine's economy.

ii. Athearn, K. (2008) Economic Losses from Closure of Shellfish Harvesting Areas in Maine

This technical article clearly describes the differences between long and short-term closures, and assesses the economic impacts on shellfish harvesting from each. Athearn repeatedly mentions the difficulty in directly comparing the closure data to the landings data because of the different time scales of the data. The most valuable information I was able to glean from the article is as follows: clam flat closures imply fewer harvestable acres per harvester, which *should* translate directly into fewer harvestable clams. Under perfect conditions, Ahearn says, shellfish landings decreases should be directly proportional to size of the closure area; however, the sheer number of external independent variables makes a direct proportion highly unrealistic. Looking at productivity (bushels/acre or lbs/acre) on local area by area basis is probably more accurate.

Ahearn calculates that long-term clam flat closures could cause annual losses in harvester sales between $288 to $14400 per intertidal acre. While Ahearn mentions that not all clam flats are equally productive and that closures affect some harvesters more than others, the report fails to take into account several things: 1) Not all clam diggers are licensed. In Frenchman Bay, there are approximately 300 licensed harvesters. 2) Not all clam harvesters adhere to the rules about not digging in a prohibited or restricted (closed) clam flat. Recreational harvesters may not be as well informed about where digging is and is not allowed. Licensed harvesters may not care, because they have to find a way to make a living, regardless of pollution closures.

iii. **Flora, CB. and Flora, JL. Creating Social Capital. *Rooted in the Land*.**

Social capital is reciprocity and trust between parties—it helps groups and individuals circumvent the vertical system of local governments. Social capital assists stakeholders in the creation of a horizontal system in which organizations, individuals, and governing bodies function as equals. In a coastal community, like the towns in the Frenchman Bay watershed, social capital is tied very closely to natural capital. Coastal communities, especially those on the Eastern Seaboard, have deep historical roots in commercial fishing.

The Frenchman Bay Partners figured out early on that cooperation between research institutions, land trusts, municipal officials, marine industries representatives, and Acadia National Park would be a good way to facilitate change outside the vertical system of the Maine State government. The Frenchman Bay Partners organization is the 'social infrastructure' which allows the stakeholders to work together outside their individual groups organizations. Much of this social capital depends on the acceptance of the threats facing the resources in the Bay, as well as the local individual investment or ties to place.

iv. **Magnuszewski et al. (2005) Conceptual Modeling for Adaptive Environmental Assessment and Management in the Barycz Valley, Lower Silesia, Poland.**

This article details a conceptual modeling style similar to the style used in Miradi software, but the authors use different terminology. The major difference between the management model for the Barycz Valley project and the Frenchman Bay Partners is that the Partners are focused on ecological marine management, as opposed to land management. The economic analysis for the conceptual model in the article is much more fleshed out than anything the Partners currently have.

The authors attributed part of the success in the Barycz Valley project to the empowerment of local official; the lack of a strong top-down framework eliminated any kind of "paternalistic relationship" between the NGO and the "client," allowing for trust between parties. The goal of the project was to provide stakeholders with what they needed, though the authors believed that direct stakeholder involvement would have been detrimental to the project—both expensive and a waste of precious time.

The approach to indirect stakeholder involvement in the Barycz Valley project is completely different from the approach taken by the Frenchman Bay Partners. Frenchman Bay Partner stakeholder participation grew out of informal stakeholder interviews. Back when Jane Disney was the Director of the MDI Water Quality Coalition, she did a kayak tour of Frenchman Bay and interviewed waterfront homeowners and fishermen about the major issues in the bay. From there, stakeholders were invited to meetings and the Partners grew naturally out of the interest of fishermen, waterfront homeowners, aquaculturists, local research institutions, colleges, and businesses who considered Frenchman Bay a valuable resource. The article documents the process for the Barycz Valley project with NGOs as the starting point, then local professionals, and finally stakeholders.

Magnuszewski, et al. (2008) have an economic-centric regional sustainability model. The list of 'measurable' key variables used to find sustainability indicators are as follows: profits from green local producers, profits from green tourism, gross local product production, and profits from crops. The authors stress early involvement and graphics in the communication of models to stakeholders to promote full understanding and ownership of the process.

I thought the following quotation was particularly relatable to the Frenchman Bay Partners situation: "People thus empowered [through working together outside of the hierarchy of government] might be better prepared to adapt ideas and experience from abroad to their local reality, because they are capable of detecting failures and improving them" (Magnuszewski, et al 2008).

v. **Schwartz, M.W. et al. (2012). Perspectives on the Open Standards for the Practice of Conservation**

The authors helped 5 distinct conservation groups develop conservation action plans using Miradi software, and discussed their experience. This article gives a review of the Open Standards for the Practice of Conservation (OS) and its strengths and weaknesses as a tool. Despite the great deal of training support and efforts to build a "community of practice" around implementing practices outlined in the OS, there is little literature around its successes or weaknesses. Goal-setting, the visual aid of Miradi software, and cyclic adaptive structure are mentioned as strengths of the OS. Weaknesses are related to the "regimented and prescriptive" nature of the framework, dealing with large-scale threats or projects, and terminological complexity.

The authors recommend the creation of a sharing library, so that users may present their own case studies, which may allow users to better reconcile the tension between the prescriptive nature of the framework and the adaptability of the planning software. To mitigate the difficulties presented by terminological complexity, the authors recommend the reduced usage of inflammatory language, like "threats," substituting for other less inflammatory words such as "pressures." Another method of mitigating terminological complexity is to revise the OS instructional materials using restoration ecology concepts and terminology. The authors suggest linking OS technology with emerging conservation tools, so that it can be more user-friendly.

In summary, the major constructive criticisms the authors provide about OS are about Miradi software—users want to *share*. A sharing library and the ability for users to contribute to the open-source codes are two great suggestions, from which all users could potentially benefit. The sharing will contribute to the literature about the OS, which perhaps can aid conservation-based groups in deciding whether or not it is economically beneficial to invest in the Miradi software package.

vi. **Quinby, K. and Petersen, C. (2007). Resource management in a small Maine town: monitoring, conserving, and managing clam flats in Bar Harbor**

This article was created to advise the Bar Harbor Marine Resource Committee on the monitoring, conservation, and management of Bar Harbor clam resources, particularly the Hadley Point clam flats. The article points out major density trends at Hadley Point (higher densities since recruitment event in 2005, higher densities on the eastern side than on the western side, lower densities in general since 1999).

Quinby and Petersen give an overview of *Mya arenaria* biology and ecology as well. Clams live anywhere from 4 to 28 years, but reach sexual maturity at anywhere from 2-10 years. North of Cape Cod, it seems that clams have only one reproductive cycle per year. There are two life stages, the pelagic larval stage and the mostly sedentary, infaunal adult stage. Hydrodynamics, or swirling, has an effect on recruitment and settlement, which is why some management practices include increasing clam flat texture with brush, even if there is no documentation of effectiveness. Post-settlement mortality is usually high and variable, and environmental conditions affect clam growth rates. Sediment pH is becoming more of a factor in post-settlement mortality and clam growth.

The article summarized the current practices of Town of Bar Harbor with regards to the shellfish resource, and gave recommendations for management at Hadley Point in the future (yearly surveys of at least 30 clams/survey site, and establishment of permanent survey sites). There are many different challenges in shellfish management: conflicts with other industries, such as mussel harvesting and “bait” worm harvesting; water quality issues, such as pollution or red tide; conservation practices, like rotational closures and “brushing”; changes in sediment pH due to ocean acidification; and threats from natural and introduced predators, such as green crabs. The biggest difficulty in shellfish management is conflicts with other industries—not only are there conflicts of interest in harvesting practices (because mussels, clams, and bait worm harvest areas all overlap), but there are conflicts in the scales of management as well. Mussel harvesting and bait worm harvesting industries are managed on the state scale, as opposed to the local scale of the town shellfish ordinance.

The article ends with the recommendation that experimental enhancement of clam recruitment should be *documented*, as well as the effects of conservation closures.

vii. Quinby, K. and Therkildsen, N. (2003). Clam Surveys and Management in Bar Harbor

This article is a final project from College of the Atlantic students in the Field Ecology and Data Analysis course from 2003.

The purpose of the article was to identify trends in the clam census survey data and provide management suggestions for the future. The authors note that the survey methods were relatively consistent because the data collection followed the guidelines in the *Clam Management Handbook*. The distribution of the data in each location surveyed was not normal, so the authors found it difficult to do any real statistical analysis on the data.

Quinby and Therkildsen suggest that in the future, surveys should be designed based on the type of data analysis desired. For instance, trying to pinpoint biologically important feature trends or differences in clam flat productivity might call for more extensive and consistent survey techniques (such as sampling the same areas in the same years at the same time of year).

The authors also list suggestions for the Bar Harbor Clam Committee: regularly defined (with GPS) survey sites, use of the *Clam Management Handbook*, standard data sheets, setting a minimum sample size for power analyses, and survey every year to improve consistency in data collection.

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