

The history of commercial freshwater mussel harvest in southern Ontario: a short-lived fishery with long-lasting consequences

CATRIONA HAYES MORRIS¹ and TODD J. MORRIS^{2,*}

¹Brampton, Ontario L6X 1P7 Canada

²Great Lakes Laboratory for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 867 Lakeshore Road, Burlington, Ontario L7S 1A1 Canada

*Corresponding author: todd.morris@dfo-mpo.gc.ca

Hayes Morris, C., and T.J. Morris. 2024. The history of commercial freshwater mussel harvest in southern Ontario: a short-lived fishery with long-lasting consequences. *Canadian Field-Naturalist* 138(3): 205–216. <https://doi.org/10.22621/cfn.v138i3.3391>

Abstract

Freshwater mussels (Bivalvia: Unionidae) have long been an important aquatic resource for humans, and North America's Indigenous nations have harvested them for over 10 000 years. European exploitation began in the latter half of the 19th century, initially focussing on the collection of pearls and later shifting to the manufacture of buttons at the onset of the 20th century. By 1911, Canadian pearl button factories operated in Windsor, Berlin (now Kitchener), and Trenton, Ontario, and, by 1921, Ontario shell was being exported to factories in the United States. The Canadian harvest did not last long and ended by the mid-1940s as resources dwindled because of overexploitation, pollution, and industrial shifts to other raw materials for buttons (e.g., plastics). Annual river-specific harvest ranged from ~ 66 to 110 tonnes with a maximum of 291 tonnes (~1.1–4.4 million animals) collected at Dunnville on the lower Grand River in 1915. Although detailed collection information is lacking, species such as Mucket (*Actinonaias ligamentina*), Threeridge (*Amblema plicata*), and Round Pigtoe (*Pleurobema sintoxia*, now listed federally as Endangered) were targetted, while Purple Wartback (*Cyclonaias tuberculata*, also now Endangered) was discarded (i.e., killed). Commercial harvests typically targetted adults, because they provided the desired quantity and type of material, resulting in death. Recent studies have shown that this type of directed mortality can have the greatest impact on the long-term persistence of these populations and, although the specific impacts of the historical harvest cannot be determined, it is likely that these harvests contributed to the current state of imperilment of this fauna.

Key words: Bivalvia; Unionidae; history; button industry; Grand River; Thames River

Introduction

Freshwater bivalves are among the most imperilled taxa worldwide with 40% of species considered to be at-risk (Lopes-Lima *et al.* 2018). Within this group, the freshwater mussels in the order Unionida have experienced important large-scale declines and are now considered the most at-risk with more than two thirds of North America's ~300 species considered to be at serious risk of extinction (Williams *et al.* 1993; Lopes-Lima *et al.* 2018). Bogan (1993) identified 19 extinctions within the North American freshwater mussel fauna. Causes of these declines have been well studied and they can be attributed to broad-scale habitat destruction from historical land-use practices and resource extraction, pollution from industrial sources such as pulp and paper mills, instream flow modifications from dams and impoundments, loss of host fishes, invasive species (e.g., dreissenid mussels), and overexploitation for

buttons and pearls (Bogan 1993; Haag 2019).

Efforts are underway across North America to stop these declines and to recover populations of many freshwater mussels. In Canada, 20 species (36%) have been assessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Extirpated to Special Concern. Almost all are now the beneficiary of a federal recovery strategy (for Extirpated, Endangered, or Threatened species) or a management plan (for Special Concern species) under the Canadian *Species at Risk Act (SARA)* with a goal of protecting and recovering species where possible (SARA 2002). During the first 15 years under *SARA*, meaningful progress has been made on many recovery actions for freshwater mussels particularly in areas relating to understanding population ecology and habitat needs; however, less progress has been made on understanding and mitigating threats (Drake *et al.* 2021). Because freshwater mussels can be very long-lived with life-

spans exceeding 100 years in some cases (Haag and Rypel 2011), it is important to assess not only current threats but also, where possible, historical threats. Commercial harvest for the production of buttons and/or the collection of pearls (Figure 1) is one threat that no longer occurs but whose impact undoubtedly remains imprinted on the current faunal composition.

Freshwater mussels (*Bivalvia*: Unionidae) have long been an important aquatic resource, having been harvested by North America's Indigenous nations for over 10 000 years (Haag 2012). Examination of middens and other archaeological sites suggests that, while mussels were used primarily for food, shells were also used for other purposes including tools (e.g., spoons, dippers, and scrapers), fishing lures, and less often for decoration (Haag 2012). The collection, use, and trade of freshwater pearls was a common practice amongst many Indigenous communities as well. While we recognize the longstanding traditional uses of freshwater mussels by North America's Indigenous nations, we focus on commercial uses by European settlers of Turtle Island (North America).

Methods

We examined historical newspapers, permits, and first-person accounts to assess the potential impacts of one historical threat, the shell button industry, on freshwater mussels in southern Ontario. Achieving an understanding of the scope, scale, and specific composition of Ontario's historical commercial mussel harvest will assist recovery practitioners in assessing the potential impact of past exploitation on the modern assemblage.

Results and Discussion

Early North American button manufacturers

Southern Ontario's freshwater mussel shell harvest was closely tied to the American button industry, which was centred in Muscatine, Iowa, beginning in the late 19th century. By 1898, there were more than a dozen factories employing an estimated 1500 people operating in Muscatine, where a single factory produced more than 4 million buttons for the 1897 holiday season (Haag 2012). Between 1908 and the 1920s, the industry used an annual average of 44 000 to 66 000 tonnes of shell annually, reaching a peak around 1912 (Neves 1999; Knopp 2012). This industry quickly outcompeted the exploitation of mussels for pearls, which could be worth more but were rare (Haag 2012). In the United States (US), Johann Boeple is identified as being largely responsible for the start of the commercial industry in the 1890s (Thiel and Fritz 1993); however, there are references to the utility of mussel shell in button making as early as 1802 (Haag 2012). By 1912, 196 factories across 20 states were active in the industry (Coker 1919). Many US mussel beds were commercially exhausted as early as 1899 (Smith 1899), before the Ontario industry was in full operation. This decline of US shell resources may have spurred interest in the availability of Canadian shell to supplement the expanding industry.

The Ontario harvest begins

The Ontario shell button industry traces its origins to around 1866, when Pioneer Button Works, owned by Emil Vogelsang and H.S. Huber, operated



FIGURE 1. a. Freshwater mussel shell collected from southern Ontario showing evidence of drilling to produce shell buttons, along with a collection of buttons produced from freshwater mussels from the Mississippi River in Muscatine, Iowa, USA. b. Purple Wartyback (*Cyclonaias tuberculata*) showing freshwater pearls collected from southern Ontario specimens of multiple species. Photos: Todd J. Morris.

in Berlin (now Kitchener), Ontario (Kitchener Waterloo Record 1979). At this time, button manufacturers were familiar with making buttons from a variety of natural materials such as wood, vegetable ivory (tagua nuts), and bone, and recent activities in the US sparked an interest in the use of shell material. In 1871, Pioneer Button Works became known as the Shantz Button Manufacturing Company and went on to operate as Dominion Button Works from 1912 until its closure in 1964. Under this name, it would become a major player in the Canadian pearl button industry, acquiring shell from local suppliers on the Grand and Thames rivers (Kitchener Waterloo Record 1979). Other shell button companies were soon created in Ontario, with the Windsor Pearl Button Company opening in 1908 (Evening Record 1908), the Elmira Button Factory in 1909 (Elmira Signet 1909), and the Canadian Pearl Button Company in 1911 (Trenton Courier 1911a). The opening of commercial harvest of mussels in Ontario occurred at roughly the same time as these factories were beginning to operate, with Arthur Ullyot beginning to fish for mussels in the lower Grand River from Port Maitland through Dunnville and into the Feeder Canal around 1910 (Ullyot 1917). Detweiler (1918) discusses the extent of and methods used in the Grand River harvest between 1908 and 1910 and the potentially commercially important stocks extending upstream through Brantford, Paris, and as far as the confluence with the Speed River. In 1909, a location near the lower dam at Brantford was considered the best place for mussels, “as to size, quantity, and variety” (Detweiler 1918: 79). The first report of Ontario mussels being shipped south of the border to support the US button industry was in 1913 or 1914, where five or six railway cars of shell from ~1 km south of York, Ontario, were reportedly shipped to Buffalo, New York (Detweiler 1918).

These button manufacturers were involved to varying degrees with the direct exploitation of Ontario mussels. In an advertisement, the Windsor Pearl Button Company (1917) declared that it was the “largest manufacturer of fresh water pearl buttons in Canada”. There are records of the company receiving imported US shell from the Illinois River (Evening Record 1908), but none indicating the use of shell from Ontario. In 1929, the company was sold to Alfred Pollock of Montréal, for \$90 000 (Burlington Hawk Eye 1929). Although clearly a major player in the Ontario pearl button industry, no records could be found indicating that the operation ever relied on the Ontario harvest.

The Gateman Comb and Button factory started operating in Elmira, Ontario in August 1909 and J.B. Gateman hired Mr. Kruger, from Springfield, Massachusetts, to run the pearl button division of this factory (Elmira Signet 1909). In 1910, Gateman pro-

posed disposing of his factory in Berlin in favour of improvements to his Elmira factory (Elmira Signet 1910a). He would partner with Arthur Ullyot later that year (Elmira Signet 1910b). It is not explicit where this company’s shell material came from; however, as Ullyot is known to have been harvesting shell from the lower Grand River at this time, it is reasonable to conclude that Grand River shell supported this new partnership (Ullyot 1917). Ullyot’s next venture, the Canadian Pearl Button Company in Trenton, opened in early 1911 (Trenton Courier 1911b). He started with imported shell from Mississippi, USA, but suspected that local shell procurement would be possible (Trenton Courier 1911a). In March, an article in the Trenton Courier (1911c) estimated that the operation, when fully running, would employ ~100 people. By April 1917, the company was looking for harvesters and placed an ad in the Canadian Fisherman noting the “large profits” available (Canadian Pearl Button Co. 1917).

A significant impediment to the early shell harvesters was incomplete knowledge of Ontario’s freshwater mussel fauna. Before the early 20th century, formal surveys had not occurred in most watersheds. It was not until John D. Detweiler undertook a survey of various watersheds in Ontario as part of a project of the Biological Board of Canada in 1916, with the purpose of determining the “abundance, species, and commercial value of the mussels” that detailed information about Ontario mussel distributions started to become available (Detweiler 1918: 75).

Detweiler (1918) conducted surveys of the Grand River (Lake Erie watershed), the River Aux Sables (now Ausable River, Lake Huron watershed), Point Edward Bay (St. Clair River watershed), and the Nottawasaga River (Lake Huron watershed). He confirmed the well-known mussel beds in the lower Grand River that Ullyot was already fishing and a smaller but potentially commercially important fauna in the Ausable River; he believed that Point Edward and the Nottawasaga River did not offer a commercially viable resource. In addition to the surveys, he recommended further investigative work in other major rivers of southern Ontario, such as the Thames (Lake St. Clair watershed), Sydenham (Lake St. Clair watershed), Welland (Niagara River watershed), and the Saugeen (Lake Huron watershed) which have all subsequently proven to have substantial mussel assemblages (McNichols-O’Rourke *et al.* 2012; Wright *et al.* 2017). With the exception of the Thames, none of these rivers would apparently ever be subjected to commercial mussel harvest. The Grand and Thames rivers appear to have been the focus of the Ontario button shell fishery and the following sections detail what is known about the harvest there.

The Grand River harvest

Detweiler (1918: 77) asserted that the “Grand River contain[ed] more mussels of commercial value than any other Ontario waters”. The shells found in this area were reported to have compared well to US shells (Detweiler 1918) and the Grand River (Figure 2) would eventually become the focus of the Ontario fishery. In 1910, Ullyot discovered a bed of what he called “Threeridge” in the lower Grand River (Ullyot 1917). (Difficulties in reconciling common names make precise species attributions difficult, but see section *The species in the harvest*.) He then employed a “great number of fishermen” between 1910 and at least 1917 and paid the Ontario Government \$1 for every imperial ton (1 imperial ton = 1.1 tonne) fished (Ullyot 1917: 282). By 1916, he had rights to the fishery in the Dunnville area, which he continued to hold at least through 1917 (Ullyot 1917). In 1915, 291 tonnes of shell were shipped from a point about a kilometre north of Port Maitland, with the bed apparently showing “no signs of depletion” (Detweiler 1918: 78). However, when 286 tonnes were shipped from an area upstream of Dunnville the following

year, the area was “not as productive as was anticipated” (Detweiler 1918: 78). By the next year, Ullyot (1917: 282) noted the “inevitable result that the supply each year is diminishing” as a result of the harvest. The question of renewability of mussel shells as a resource was a concern commonly remarked on during the early years of the fishery by those involved on both sides of the Canada–US border: however, the harvest continued. By 1921, elementary school children from Stromness, a town northeast of Port Maitland, earned money (10 cents/hour) separating meat from shell and as many as seven cartloads of shell at a time were sent from this endeavour to Kitchener and further points onward on the Toronto, Hamilton, and Buffalo Railway (Warnick 2003).

A decade or more later, W.H. Robinson would begin his operation further upstream in the Grand River at Caledonia, with the first recovered permit dated 1936 listing a harvest fee of \$5 per imperial ton (Figure S1). During the span of his operation, Robinson recalled the price per imperial ton varying from \$35 to \$100, with an average of 30–60 imperial tons (33–66 tonnes) of shell harvested each summer

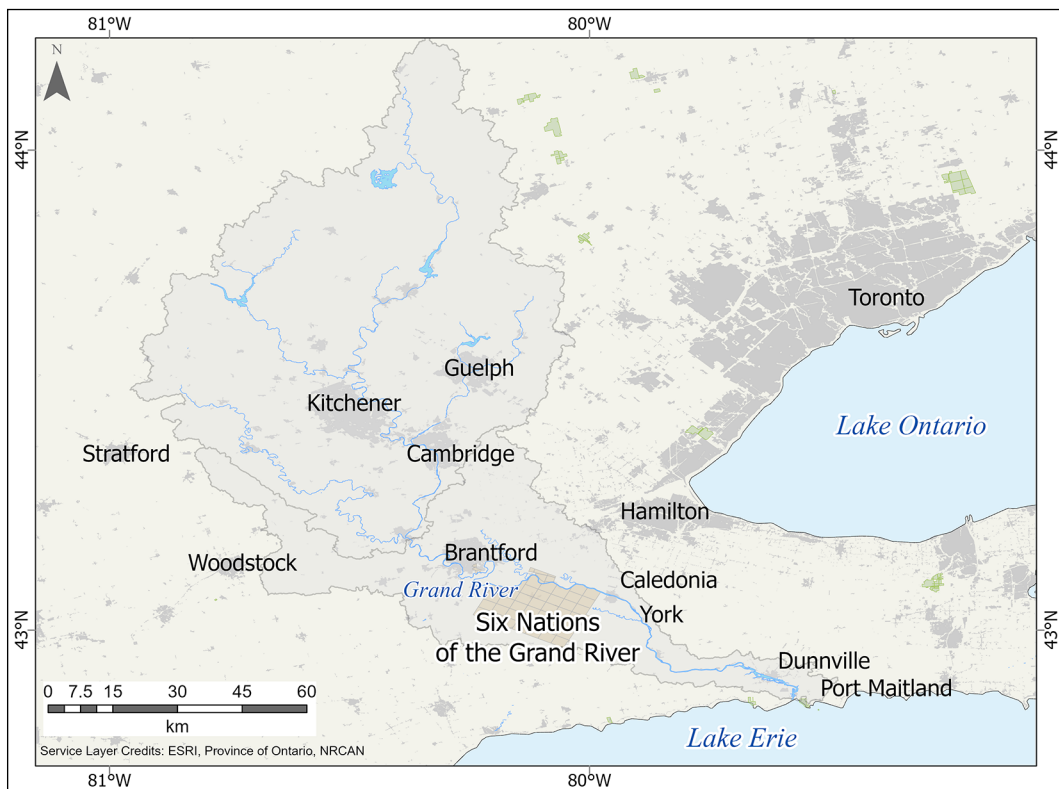


FIGURE 2. Location of the Grand River watershed in southwestern Ontario. A.A. Ullyot’s harvesting operation was focussed around the Dunnville area, while W.H. Robinson and his team worked further upstream near Caledonia.

(Figure S2). He noted that Americans could not hold the licence necessary for mussel fishing in Ontario, which was how his family became involved in the industry (Figure S2). Correspondence between Robinson and Carl Jungbluth, president of the American Pearl Button Company of Washington, Iowa (Figure S3), and between Robinson and Henry Umlandt, president of the Automatic Button Company of Muscatine, Iowa (Figure S4), in May 1944 suggest a burgeoning bidding war for his Grand River material. Each of these US buyers was offering \$80 per imperial ton, with Umlandt offering an additional \$5 per imperial ton bonus if Robinson could provide 60 imperial tons (66 tonnes) as requested. In his letter (Figure S4), Jungbluth expressed his displeasure at having his bid shared with other firms who “might be a little hard up for shells and raise the price just a little in order to get them”. It is unclear who won the rights to Robinson’s Grand River shell that summer. The fisheries were active from May or June through to mid-October, as described by those involved. Robinson described the work as a “summer operation, and only possible when the weather and water warmed up” (Figure S2).

Collection methods were labour intensive and typically involved a “hands-on” approach. Ulyot’s lower Grand operation used the methods of crowfooting, scooping, and collection by hand. Crowfooting (Figure 3) was the most common technique, using a device consisting of wire hooks attached to the ends of cords, tied to a piece of pipe, then dragged behind a boat (Ulyot 1917). In the scooping method, two flat-bottomed scows were fastened rigidly together with planks behind a gasoline-powered launch (Ulyot 1917). A man would stand in each scow with a scoop net that was affixed with spikes and then dragged through the riverbed (Ulyot 1917). Detweiler observed that two men and two boys, using these two methods, were able to fish and clean (i.e., boil and remove the soft tissue) four and a half tonnes of shell in just three and a half days (Detweiler 1918). Lloyd Newth who, as a 16-year-old, worked on Robinson’s operation in Caledonia, reported using a hook and boat method (likely crowfooting) upstream near Caledonia (Newth pers. comm. 2012). Gathering by hand was considered quickest, but only possible in shallow water, which was often not where the beds were located (Ulyot 1917).

The Thames River harvest

The Thames River was not included in Detweiler’s 1916 survey but was believed to be part of an area that contained commercial shells (Detweiler 1918). As such, the operation of G. Frank Neely is the only significant source of information so far available. Neely harvested mussels from the Thames from

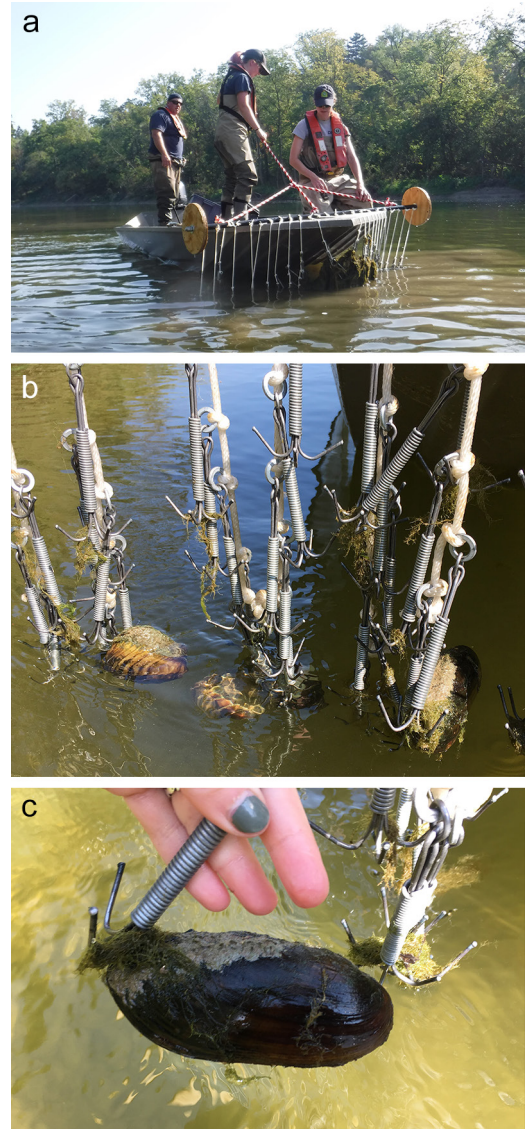


FIGURE 3. a. Modern-day application of the crowfooting technique being used to sample freshwater mussels on the lower Grand River near Brantford. b. Retrieval of the device (brail) showing multiple freshwater mussels attached to the crowfeet. c. A mature female Black Sandshell (*Ligumia recta*) grasping the tine of a crowfoot. Photos: Fisheries and Oceans Canada.

~1935 to at least 1945 (Figure S5; Stewart 1992). An article purportedly in the London Free Press (it had been retyped with an incomplete date) stated that he held a permit on the Thames from Putnam to Chatham, which comprised most of the lower Thames River (~200 river km; Figures 4 and S5). An area below the Munsee–Delaware First Nation Reserve,

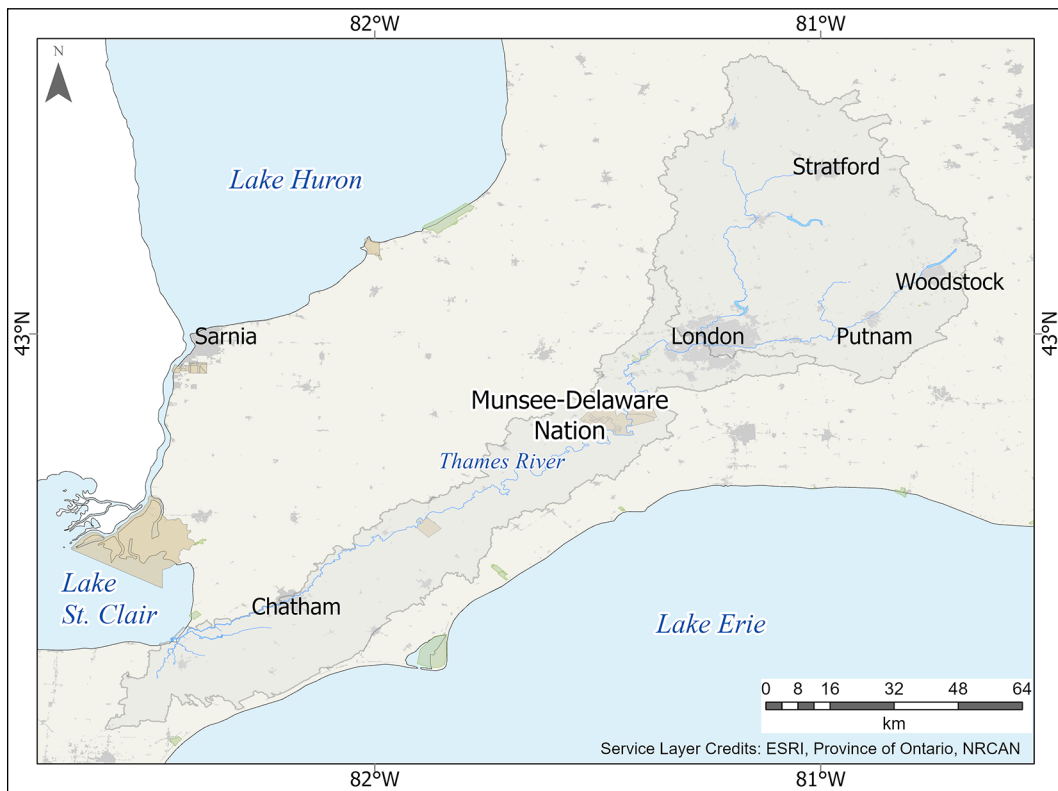


FIGURE 4. Location of the Thames River watershed in southwestern Ontario. G. Frank Neely held exclusive rights to the mussel fishery on the river from Chatham upstream to Putnam.

~25 km downriver from London, Ontario, was identified as one of the “best clam beds in North America” with the area below the dam at Springbank Park, in London, identified as another particularly productive stretch (Figure S5). The area below the Munsee–Delaware First Nation Reserve was of particular abundance, and Neely reported finding an “inexhaustible supply of clams in that bed” (Figure S5). The Munsee location was mainly harvested with farm forks, where one could harvest as many as 13 mussels “in one fork full”, while the Springbank site in one instance produced 8.25 tonnes in two days (Figure S5). No other comment on the methods used by the Neely operation has been found. In 1945, The royalty per imperial ton reported in 1945 was \$5 (Figure S5). Stewart (1992) reports that ~110 tonnes of shell were shipped yearly to factories including the Dominion Button Manufacturers of Kitchener. However, factories in Guttenberg and Muscatine, Iowa, reportedly received most of the shell material from Neely’s operation at this time (Figure S6).

In 1945, Neely appealed to the city of London, Ontario, to stop sewage pollution in the Thames

River because it was believed to be diminishing the quality of his shell material (Figure S5). Individuals from the Guttenberg factory had arrived to investigate the cause of “purplish patchy discoloration” in the Thames River Black Sandshell (*Ligumia recta*) and to determine why the Thames River, “a main stay of the button industry” was turning out inferior shells (Figure S5). Paper mill runoff was proposed as a source of pollution but, without a mill in the watershed, the problem was attributed to pollution from London’s disposal works (Figure S5). A letter from Mrs. A.Z. Neely (wife of G. Frank Neely), dated 10 February 1965 stated: “The water is so polluted that it is difficult to get white shells without discoloration from the sewage being dumped in the river” (Figure S6). The shells of Black Sandshell in this area continue to have a patchy purple colouration (Figure 5).

The species in the harvest

Across the North American industry, the ideal shell for button processing was “unstained, white or iridescent nacre of moderate thickness and without exterior sculpture, which made shells difficult to cut” (Haag 2012: 304). As a result of these preferences,



FIGURE 5. Mature male Black Sandshell (*Ligumia recta*) collected recently from the Thames River watershed showing purple colouration in the umbo region similar to that described by G. F. Neely in 1945. Photo: Todd J. Morris.

knowledge of species' distributions was valuable to harvesters and button producers. Prospecting of this sort is responsible for some early records and was the impetus for Detweiler's 1916 surveys (Detweiler 1918). Medium-sized individuals were the original targets, because small shells provided few "blanks" (raw button plugs before finishing) and larger ones resulted in more waste, but the North American industry became less selective as beds were depleted (Haag 2012).

Although detailed catch records are not readily available, a number of people involved in the Ontario harvest kept records that allow for a general look at the species composition. In some cases, collection records contain scientific names, while others rely only on common names. In both cases, there are difficulties in matching historical collection reports with modern species accounts because taxonomy has changed over the last century and common names are known to be regional specific and, in some cases, culturally inappropriate/offensive (see Pfeiffer *et al.* 2024 for a discussion). In some cases, US involvement in the developing Ontario industry likely resulted in local American names being assigned to Canadian specimens bearing a similar appearance (e.g., butterfly or washboard). We have attempted to

reconcile the historically provided common/scientific names with the modern scientific literature and our current understanding of species distributions within Ontario. Where common names have been deemed to be inappropriate or offensive they have been redacted.

Detweiler (1918) identified nine commercially important species in the lower Grand River (Table 1), with Threeridge (*Amblema plicata*) and Pink Heelsplitter (*Potamilus alatus*) the two most likely commercially harvestable species. He did, however, note that the pink nacre of Pink Heelsplitter reduced its value to button manufacturers. Of the mussels that Ullyot reported (Table 2), Threeridge appears to have been the target species of his operation just as Detweiler had predicted (Ullyot 1917). Robinson's operation further up the river at Caledonia in the 1930s and 1940s reportedly encountered six or seven species but without the inclusion of scientific names it is difficult to narrow down the exact species that were the focus of this operation (Table 3). In the Thames River, a London Free Press article (Figure S5) identified eight species that were likely part of Neely's harvest although the focus was apparently on Black Sandshell, Mucket (*Actinonaias ligamentina*), Plain Pocketbook (*Lampsilis cardium*), Round Pigtoe (*Pleurobema sintoxia*), and Threeridge (Table 4).

TABLE 1. Species present in the Grand River in 1916 and of commercial importance (Detweiler 1918).*

Detweiler's name	Current name
Pink heelsplitter (<i>Lampsilis alata</i>)	Pink Heelsplitter (<i>Potamilus alatus</i>)
Fat mucket (<i>Lampsilis luteola</i>)	Fatmucket (<i>Lampsilis siliquoides</i>)
Black sand-shell (<i>Lampsilis recta</i>)	Black Sandshell (<i>Ligumia recta</i>)
Pocketbook (<i>Lampsilis ventricosa</i>)	Plain Pocketbook (<i>Lampsilis cardium</i>)
Three-horned warty-back (<i>Obliquaria reflexa</i>)	Threehorned Wartyback (<i>Obliquaria reflexa</i>)
Maple leaf (<i>Quadrula lachrymose</i>)	Mapleleaf (<i>Quadrula quadrula</i>)
Blue-point (<i>Quadrula plicata</i>)	Threeridge (<i>Amblema plicata</i>)
Wabash pig-toe (<i>Quadrula rubiginosa</i>)	Wabash Pigtoe (<i>Fusconaia flava</i>)
Three-ridge (<i>Quadrula undulata</i>)	Threeridge (<i>Amblema plicata</i>)

*Detweiler's (1918) names have been matched to contemporary species following the nomenclature of Williams *et al.* (2017).

TABLE 2. Species occurring in the Grand River fishery at Dunnville (Ullyot 1917).*

Ullyot's name	Current name
Butterfly (<i>Pegiola securis</i>)†	Likely Deertoe (<i>Truncilla truncata</i>)
[Redacted] (<i>Quadrula ebena</i>)†	Likely Round Pigtoe (<i>Pleurobema sintoxia</i>)
Pig-toe (<i>Quadrula undulata</i>)	Threeridge (<i>Amblema plicata</i>)
Three-ridge/washboard (<i>Quadrula heros</i>)†	Likely Threeridge (<i>Amblema plicata</i>)

*Ullyot's (1917) names have been matched to contemporary species following the nomenclature of Williams *et al.* (2017). The common name deemed racially or culturally inappropriate has been redacted.

†Species as identified does not occur in Canada, but matched to Grand River species with similar morphology.

TABLE 3. Species occurring at W.H. Robinson's Grand River fishery at Caledonia (Figure S2).*

Robinson's name	Current name
Threeridges	Threeridge (<i>Amblema plicata</i>)
Mucket	Mucket (<i>Actinonaias ligamentina</i>)
Pocketbook	Plain Pocketbook (<i>Lampsilis cardium</i>)
Redacted	Creeper (<i>Strophitus undulatus</i>)
Sheepnose†	Likely Round Pigtoe <i>Pleurobema sintoxia</i>)
Pigtoes	Likely Round Pigtoe (<i>Pleurobema sintoxia</i>) or Wabash Pigtoe (<i>Fusconaia flava</i>)

*Robinson's (Figure S2) names have been matched to contemporary species following the nomenclature of Williams *et al.* (2017). The common name deemed racially or culturally inappropriate has been redacted.

†Species as identified does not occur in Canada, but matched to Grand River species with similar morphology.

Numbers of mussels harvested

In an effort to convert the catches reported by Ullyot and Neeley in tonnes to a measure of individuals, we examined a collection of recently surveyed shells (within the last five years) maintained by Fisheries and Oceans Canada at the Canada Centre for Inland Waters in Burlington, Ontario, Canada (Table 5). The average mass of a single valve of each species was determined and the number of individuals required to equal one tonne of shell was calculated using the following equation:

$$\text{No. individuals}_{\text{tonne}} = 2 \frac{1\,000\,000 \text{ g/tonne}}{\text{mass}_{\text{valve}} \text{ (g)}}$$

This approach assumes that the shell mass of individual species has remained constant over the last 100 years in these rivers, an assumption that we can not verify given the lack of historical shell material. We also have no information on the relative proportions of each harvested species in the reported catches and believe it is unlikely that the harvesters were collecting single species. However, as discussed above, the catch likely consisted of a combination of the species

TABLE 4. Species occurring at Neely's Thames River fishery (Figure S5).*

Neely's name	Current name
Black Sand clams	Black Sandshell (<i>Ligumia recta</i>)
Mucket	Mucket (<i>Actinonaias ligamentina</i>)
Pocket Book	Plain Pocketbook (<i>Lampsilis cardium</i>)
Pig Toes	Likely Round Pigtoe (<i>Pleurobema sintoxia</i>) or Wabash Pigtoe <i>Fusconaia flava</i>)
[Redacted] Heads†	Likely Round Pigtoe (<i>Pleurobema sintoxia</i>)
[Redacted] Foot	Creeper (<i>Strophitus undulatus</i>)
Three Ridge	Threeridge (<i>Amblema plicata</i>)
Warty Backs	Likely Purple Wartyback (<i>Cyclonaias tuberculata</i>)

*Neely's names have been matched to contemporary species following the nomenclature of Williams *et al.* (2017). Common names deemed racially or culturally inappropriate have been redacted.

†Species as identified does not occur in Canada, but matched to Grand River species with similar morphology.

TABLE 5. Mean shell mass of three species of freshwater mussel collected during the last five years from southern Ontario rivers.

Species	No. of valves	Mean shell mass, g/valve (SE)	No. individuals/tonne*
Mucket (<i>Actinonaias ligamentina</i>)	15	105.01 (17.71)	4761 ± 1023
Threeridge (<i>Amblema plicata</i>)	18	92.18 (14.14)	5423 ± 1585
Round Pigtoe (<i>Pleurobema sintoxia</i>)	24	26.59 (2.17)	18 791 ± 2583

*The number of individual animals required to equal one tonne was determined using the equation:

$$\text{No. individuals}_{\text{tonne}} = 2 \frac{1000\,000 \text{ g/tonne}}{\text{mass}_{\text{valve}} \text{ (g)}}$$

(and perhaps others) represented in Table 5. As such, we believe our equation represents a reasonable approach to translate the reported masses into estimates of number of individuals harvested.

Both Ulliyot (1917) and Detweiler (1918) have indicated that the most commercially viable and targeted species in the lower Grand River fishery was Threeridge, so it is reasonable to use that value from Table 5 to estimate population scale harvests in the Grand River. Detweiler (1918) reported approximate catches of 291 tonnes in 1915 and 286 tonnes in 1916. If we assume a catch comprising only Threeridge, we estimate that ~ 2.86 million individual mussels were removed over that two-year period. In the decades to follow and a little further upriver, the Robinson camp set up operation on the west bank of the river about 150 m downstream of the bridge in Caledonia. Although they only operated in a short 3-km stretch of the river, they processed a large number of shells annually (Newth pers. comm. 2012; Figure 6). Robinson reports harvesting ~33–66 tonnes annually of a number of species including Mucket, Threeridge, and what we believe was likely Round Pigtoe. Using the values in Table 5 we estimate that the Caledonia harvest ranged from 142 000 (pure Mucket) to 1 125 000 (pure Round Pigtoe) animals per year depending on

the species composition and yearly harvest rates. A mixed harvest, the likely scenario, results in estimates intermediate to the two presented above.

In the Thames River, the Neely operation apparently also harvested a mixture of species. Given the broad geographic range of the Neely harvest, extending from the shallow, clear waters of the upper Thames down through the deeper, turbid reaches of the lower river, it is likely that the species assemblage differed greatly across his permitted range, making harvest of a single species impossible (Figure S5). Operating for at least a decade, Neely and his crew reportedly collected around 110 tonnes per year on average. A harvest of that scale could result in the collection of 474 000–1 870 000 animals per year depending on which species contribute to the harvest. Over the decade of operation, the harvest would not have been insignificant at ~5.5–12 million animals.

Implications of historical harvests on today's mussel populations

While the absence of detailed catch records coupled with the lack of historical time series of mussel sampling and abundance in these rivers makes it difficult to properly assess the long-term impacts of these commercial harvest activities, it is likely that these harvests negatively impacted the populations



FIGURE 6. Large pile of shells collected by the W.H. Robinson operation near Caledonia, Ontario. Harvested animals have been boiled to remove the soft tissue and shell material is being prepped for shipment to button factories by rail. Source: W.H. Robinson (Figure S2).

in ways that are still evident today. Haag (2012) described harvest methods that targetted mature individuals of medium to large size while Haag and Rypel (2011) have shown that many of the species targetted in the Ontario harvest demonstrate late maturity and long life spans (i.e., Threeridge up to 54 years; Mucket 50 years; *Pleurobema* spp. 45 years). Species with these characteristics are defined as equilibrium life history strategy species (Haag 2012) and are known to be common in stable, unchanging habitats. Young and Koops (2011: 4) characterized these species as “adult survival dominant”, while van der Lee and Koops (2023) demonstrated that altering adult survival rates (e.g., targetting adults for harvest) has the largest proportional impact on population growth rates and ultimately the long-term viability of these populations, particularly when these populations are near carrying capacity.

By the mid-1940s, the North American shell button industry was in steep decline (Haag 2012). Overfishing and pollution had contributed to declines in mussel stocks and the introduction of plastic buttons and the zipper had changed the market forever. The Canadian shell button industry seems to have followed suit, with A.Z. Neely in 1965 stating that “no one has taken clams from that spot since [1945]”, referring to the location of the Neely operation (Figure S6). Robinson’s operation on the Grand also appears to have run its course by this time. Even during the early years of the fishery, Ulliyot (1917: 282) lamented

the “diminishing supply” and wondered whether the cause was “the quantity we have fished”. While it is encouraging to see that all of the species identified as targets of the Grand and Thames River harvest can still be found in these systems 60–70 years later (McNichols-O’Rourke *et al.* 2012), it would be unwise to think that the harvest had no impact. The very nature of a commercial mussel harvest, targetting large mature individuals, particularly those adapted to stable non-changing habitats, is a recipe for disaster. Minke-Martin *et al.* (2015) surveyed five sites in the lower Grand River at Dunnville in the area where Ulliyot operated a century earlier and, despite investing 30 hours of searching, found not a single live Threeridge—the species that was the target of the early Grand River fishery so many years ago. Modern day efforts to protect and recover freshwater mussel populations in these two rivers (e.g., DFO 2019) may be hindered by the lasting effects of this poorly understood but important historical harvest.

Acknowledgements

We thank Michael King for his time and effort spent tracking down many of the sources in this manuscript and Serena Ableson, reference librarian with Fisheries and Oceans Canada, for finding those that Michael could not. We are grateful to everyone who took time over the last century to record their thoughts on Ontario’s harvest and its mussel resource. Thank you to Jack Robinson for providing insight into W.H.

Robinson's (his father) operation on the Grand River and to Lloyd Newth for details of his experiences working on that operation. We thank Julia Colm for producing the maps for this report. Carolyn Hayes and Kelly McNichols-O'Rourke provided valuable editorial comments on an early draft. This work was presented at the 2023 Canadian Freshwater Mollusk Research Meeting in Burlington, Ontario, Canada.

Author Contributions

Writing – Original Draft: C.H.M. and T.J.M.; Writing – Review & Editing: C.H.M. and T.J.M.; Conceptualization: T.J.M.; Investigation: C.H.M. and T.J.M.; Methodology: C.H.M. and T.J.M.; Funding Acquisition: T.J.M.

Literature Cited

- Bogan, A.E.** 1993. Freshwater bivalve extinctions (Mollusca: Unionoida): a search for causes. *American Zoologist* 33: 599–609.
- Burlington Hawk Eye.** 1929. Moir brothers sell pearl button plant. *Burlington Hawk Eye* 7 December: 2. Accessed 15 June 2023. <https://newspaperarchive.com/other-articles-clipping-dec-07-1929-3932384/>.
- Canadian Pearl Button Co., Ltd.** 1917. [Advertisement] *Canadian Fisherman* 4(4): 137.
- Coker, R.E.** 1919. Fresh-water mussels and mussel industries of the United States. *Bulletin of the Bureau of Fisheries* 36 (1917–1918): 1–89. Accessed 3 March 2025. <https://www.biodiversitylibrary.org/page/29931786>.
- Detweiler, J.D.** 1918. The pearly freshwater mussels of Ontario. Supplement to the 7th annual report of the Department of the Naval Service Fisheries Branch, Contributions to Canadian Biology. Sessional Paper No. 38a. 1917–18: 75–92. <https://doi.org/10.5962/bhl.title.64610>
- DFO (Fisheries and Oceans Canada).** 2019. Recovery strategy for Northern Riffleshell, Snuffbox, Round Pigtoe, Salamander Mussel, and Rayed Bean in Canada. Fisheries and Oceans Canada, Ottawa, Ontario, Canada. Accessed 3 March 2025. https://wildlife-species.canada.ca/species-risk-registry/virtual_sara/files/plans/Rs-5-Mussels-v00a-2019Jul-Eng.pdf.
- Drake, D.A.R., K.A. Lamothe, K.E. Thiessen, T.J. Morris, M.A. Koops, T.C. Pratt, S.M. Reid, D.A. Jackson, and N.E. Mandrak.** 2021. Fifteen years of Canada's *Species at Risk Act*: evaluating research progress for aquatic species in the Great Lakes–St. Lawrence River basin. *Canadian Journal of Fisheries and Aquatic Sciences* 78: 1205–1218. <https://doi.org/10.1139/cjfas-2021-0143>
- Elmira Signet.** 1909. Untitled. *Elmira Signet* 26 August 1909 16(31): 1. Kitchener Public Library, Central Branch archives. Examined 14 July 2023.
- Elmira Signet.** 1910a. Untitled. *Elmira Signet* 3 February 1910 17(5): 8. Kitchener Public Library, Central Branch archives. Examined 14 July 2023.
- Elmira Signet.** 1910b. Untitled. *Elmira Signet* 28 April 1910 17(18): 1. Kitchener Public Library, Central Branch archives. Examined 14 July 2023.
- Evening Record (Windsor).** 1908. Button factory is to be started soon. *Evening Record* 8 April 1908: 1. Proquest Historical Newspapers. Examined 11 June 2024.
- Haag, W.R.** 2012. *North American Freshwater Mussels*. Cambridge University Press, New York, New York, USA.
- Haag, W.R.** 2019. Reassessing enigmatic mussel declines in the United States. *Freshwater Mollusk Biology and Conservation* 22: 43–60. <https://doi.org/10.31931/fmbc.v22i2.2019.43-60>
- Haag, W.R., and A.L. Rypel.** 2011. Growth and longevity in freshwater mussels: evolutionary and conservation implications. *Biological Reviews* 86: 225–247. <https://doi.org/10.1111/j.1469-185X.2010.00146.x>
- Kitchener-Waterloo Record.** 1979. Buttons once biggest industry. *Kitchener-Waterloo Record* 21 June 1979: 117 (p. 25 of special: Kitchener's 125th Anniversary edition). Proquest Historical Newspapers. Examined 29 May 2024.
- Knopp, L.** 2012. *What the River Carries: Encounters with the Mississippi, Missouri, and Platte*. First Edition. University of Missouri Press, Columbia, Missouri, USA.
- Lopes-Lima, M., L.E. Burlakova, A.Y. Karatayev, K. Mehler, M. Seddon, and R. Sousa.** 2018. Conservation of freshwater bivalves at the global scale: diversity, threats and research needs. *Hydrobiologia* 810: 1–14. <https://doi.org/10.1007/s10750-017-3486-7>
- McNichols-O'Rourke, K.A., A. Robinson, and T.J. Morris.** 2012. Summary of freshwater mussel timed search surveys in southwestern Ontario in 2010 and 2011. Canadian Manuscript Report of Fisheries and Aquatic Sciences 3009. Fisheries and Oceans Canada, Burlington, Ontario, Canada. Accessed 30 December 2024. https://publications.gc.ca/collections/collection_2013/mpo-dfo/Fs97-4-3009-eng.pdf.
- Minke-Martin, V., K.A. McNichols-O'Rourke, and T.J. Morris.** 2015. Initial application of the half-hectare unionid survey method in wetland habitats of the Laurentian Great Lakes, southern Ontario. Canadian Manuscript Report of Fisheries and Aquatic Sciences 3069. Fisheries and Oceans Canada, Burlington, Ontario, Canada. Accessed 30 December 2024. https://publications.gc.ca/collections/collection_2015/mpo-dfo/Fs97-4-3069-eng.pdf.
- Neves, R.J.** 1999. Conservation and commerce: management of freshwater mussel (*Bivalvia*: Unionidae) resources in the United States. *Malacologia* 41: 461–474.
- Pfeiffer, J., J.P. Chong, S. Craft, T. Dubose, A. Franzen, M. Hove, T.A. Smith, and D. Woolnough.** 2024. Requesting feedback on potentially problematic freshwater mollusk common names. *Ellipsaria* 26: 18–21. Accessed 30 December 2024. <https://molluskconservation.org/PUBLICATIONS/ELLIPSARIA/EllipsariaSpring2024.pdf>.
- SARA (*Species at Risk Act*).** 2002. An act respecting the protection of wildlife species at risk in Canada. Government of Canada, Ottawa, Ontario, Canada. Accessed June 2024. <https://laws-lois.justice.gc.ca/eng/acts/s-15.3/page-1.html>.
- Smith, H.M.** 1899. The mussel fishery and pearl-button industry of the Mississippi River. *Bulletin of the U.S. Fish Commission* 18: 289–314. Accessed 3 March 2025. <https://spo.nmfs.noaa.gov/sites/default/files/pdf-content/fish-bull/fb18.7.pdf>.

- Stewart, W.G.** 1992. Freshwater Molluscs of Elgin County, Ontario. Self-published.
- Thiel, P.A., and A.W. Fritz.** 1993. Mussel harvest and regulations in the Upper Mississippi River system. Pages 11–18 in Proceedings of a UMRCC Symposium Conservation and Management of Freshwater Mussels. Edited by K.S. Cummings, A.C. Buchanan, and L. Koch. Upper Mississippi River Conservation Committee, Rock Island, Illinois, USA.
- Trenton Courier.** 1911a. A new industry for Trenton. Trenton Courier 9 February 1911: 6. Library and Archives Canada. Examined 12 July 2023.
- Trenton Courier.** 1911b. Canadian Pearl Button Co. Trenton Courier 2 March 1911: 6. Library and Archives Canada. Examined 12 July 2023.
- Trenton Courier.** 1911c. Purchased Gilmour office. Trenton Courier 30 March 1911: 6. Library and Archives Canada. Examined 12 July 2023.
- Ulyot, A.A.** 1917. The pearl button industry. Canadian Fisherman 4: 281–283.
- van der Lee, A.S., and M.A. Koops.** 2023. Recovery potential modelling of Purple Wartyback (*Cyclonaias tuberculata*) in Canada. Research document 2023/087. DFO Canadian Science Advisory Secretariat Research Document 2023/087. Accessed 6 March 2025. <https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/41220705.pdf>.
- Warnick, W.A.** 2003. Clamming once a Grand business. Guelph Mercury 17 October 2003: A11.
- Williams, J.D., A.E. Bogan, R.S. Butler, K.S. Cummings, J.T. Garner, J.L. Harris, N.A. Johnson, and G.T. Watters.** 2017. A revised list of the freshwater mussels (Mollusca: Bivalvia: Unionida) of the United States and Canada. Freshwater Mollusk Biology and Conservation 20: 33–58. <https://doi.org/10.31931/fmbc.v20i2.2017.33-58>
- Williams, J.D., M.L. Warren, Jr., K.S. Cummings, J.L. Harris, and R.J. Neves.** 1993. Conservation status of freshwater mussels of the United States and Canada. Fisheries 18: 6–22. [https://doi.org/10.1577/1548-8446\(1993\)018<0006:csfmo>2.0.co;2](https://doi.org/10.1577/1548-8446(1993)018<0006:csfmo>2.0.co;2)
- Windsor Pearl Button Co., Ltd.** 1917. [Advertisement] Evening Record 23 May 1917: 84.
- Wright, K.A., K.A. McNichols-O'Rourke, M.N. Sheldon, and T.J. Morris.** 2017. Freshwater mussel surveys of the Welland River watershed: 2014–16. Canadian Manuscript Report of Fisheries and Aquatic Science 3115. Fisheries and Oceans Canada, Burlington, Ontario, Canada. Accessed 30 December 2024. <https://waves-vagues.dfo-mpo.gc.ca/library-bibliotheque/40624857.pdf>.
- Young, J.A.M., and M.A. Koops.** 2011. Recovery potential modelling of Eastern Pondmussel (*Ligumia nasuta*), Fawnsfoot (*Truncilla donaciformis*), Mapleleaf (*Quadrula quadrula*), and Rainbow (*Villosa iris*) in Canada. DFO Canadian Science Advisory Secretariat Research Document 2010/119. Fisheries and Oceans Canada, Burlington, Ontario, Canada. Accessed 30 December 2024. https://publications.gc.ca/collections/collection_2011/mpo-dfo/Fs70-5-2010-119.pdf.

Received 24 June 2024

Accepted 21 February 2025

Editor: D.A.W. Lepitzki

SUPPLEMENTARY MATERIALS:

Scans of correspondence and other supplementary materials:

FIGURE S1. Ontario Game and Fish permit #168, 23 April 23 1936, authorizing W.H. Robinson to collect clam shells by hand from the Grand River.

FIGURE S2. Memoir of the Robinson Grand River clam fishery by W.H. Robinson.

FIGURE S3. Correspondence between Grand River shell fisherman W.H. Robinson and Henry Umlandt, president of the Automatic Button Company of Muscatine Iowa, 16 May 16 1944.

FIGURE S4. Correspondence between Grand River shell fisherman W.H. Robinson and Carl Jungbluth, president of the American Pearl Button Company of Washington Iowa, 26 May 1944.

FIGURE S5. Correspondence between Eileene Stewart and William G. Stewart, 23 January 1992, containing text of an article purportedly written by G. Frank Neeley and published in the London Free Press in April 1945.

FIGURE S6. Correspondence between A.Z. Neely and Eileene Stewart, 10 February 1965, discussing Neely's recollections of her husband's shelling operation on the Thames River.