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PRELIMINARY INVESTIGATION— EXTENDING THE SHIPPING SEASON on the ST. LAWRENCE SEAWAY

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PRELIMINARY INVESTIGATION--
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ST. LAWRENCE SEAWAY

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INTRODUCTION

During the ten years of its operation the St. Lawrence Seaway has brought substantial economic benefits to not only the Midcontinent region but also to all residents of the United States and Canada.[1] These benefits, in the form of reductions in the cost of transporting the Midcontinent's exports and imports, have been far greater than had been anticipated by even the staunchest supporters of the original Seaway project. This success has been achieved in spite of a four-month winter closing which prevents the Seaway from reaching its full potential. A large amount of general cargo and grain traffic which could move most economically via the Seaway presently moves through seaboard ports because of the direct and indirect effects of the winter closing. The consequent loss of economic benefits has prompted the consideration of extending the navigation season on the Great Lakes-Seaway system. Before investing the scarce resources an extension would require, careful consideration must be given to its economic viability.

This paper is a preliminary investigation into the problems of extending the shipping season on the St. Lawrence Seaway and the impact such an extension would have upon the Great Lakes region. We begin with a summary of the technical problems associated with extending the shipping season, i.e., controlling the ice in the Seaway. Next we present data for alternative improvement programs, utilizing cost projections of the U. S. Coast Guard.[2] Finally, we introduce some questions that must be considered before an informed decision can be made regarding the feasibility of extending the Seaway navigation season.

TECHNICAL PROBLEMS

Ice conditions prevent general navigation on the Great Lakes for approximately four months each winter, from about the middle of December to the middle of April, except for the carferry traffic on Lake Michigan and other local traffic in a few places. The St. Lawrence River section of the St. Lawrence Seaway is also ice-clogged during the winter. The river above Montreal is usually closed from mid-December to mid-April, while the ship channel below Montreal is open a little later in fall and a little earlier in spring. Specifically, the periods of the year when various sections of the waterway are generally closed due to ice conditions are:[3]

Soo Locks (Poe Lock).........	December 15 - April 5
Straits of Mackinac	December 15 - April 12
St. Clair River	December 15 - March 19
Lower Detroit River..........	December 15 - February 28
Lake Michigan Ports..........	December 15 - April 15
Lake Huron Ports.............	December 15 - April 5
Lake Ontario Ports...........	December 15 - April 10
Welland Canal................	December 1 - April 5
St. Lawrence River below Montreal..................	December 16 - April 1
St. Lawrence River above Montreal..................	December 12 - April 16

The St. Lawrence Seaway is formally closed from early December to mid-April because of the formation of ice in the waterways and in the locks. The actual dates when the last commercial vessels were cleared through the locks indicate the variability of the Seaway closedown dates:

1959 ... December 3	1964 ... December 7
1960 ... December 3	1965 ... December 7
1961 ... December 2	1966 ... December 10

1962 ... December 7	1967 ... December 15
1963 ... December 13	1968 ... December 14
	1969 ... December 10

If the shipping season is to be extended, there must be some method of bypassing the ice in the various sections of the Seaway, particularly in the St. Lambert's area. Some methods that could be used to keep the locks open for a longer period at the end of the season are:

1. Cutting a new bypass channel at the entrance to St. Lambert's lock
2. Flushing ice from the locks chambers
3. Introduction of warmer upstream water into the locks
4. Retarding ice formation by increasing the water velocity
5. Preventing ice from entering navigation channels with the use of ice booms
6. Preventing ice formation on the locks gates and machinery with a coating of anti-ice chemicals and by the use of infra-red lights.

In addition, more detailed weather and water temperature studies are needed to allow precise prediction of ice formation.

The St. Lambert and Cote St. Catherine locks represent the season's first ice problem. Improvements at these locks, necessary to achieve a "moderate time extension", would cost $2.5 million and permit clearing the Great Lakes system of ocean vessels that otherwise might be entrapped in the late fall.[4] Yet they are only one part of the approximately 370 miles of channels that experience heavy ice each winter. Added to the ice problems on the Great Lakes, the Montreal to Lake Erie sections of complete ice cover present formidable barriers to winter navigation on the Seaway system.

The use of ice breakers, tugs and traffic control are the methods found most effective to cope with ice in the channels and traffic lanes in spring and fall. If these lanes are to remain open into the winter and to open earlier in the spring, other methods of ice control will probably be needed. Some proposals to keep the Great Lakes ice-free that have been advanced over the years are:

1. Compressed air bubble systems or submerged pumps to circulate warm bottom water to the surface
2. A layer of protein base foam to prevent heat loss
3. Submerged oil burning heaters
4. Sinking of atomic wastes
5. Construction of dams to prevent rapids, and other methods to prevent heat loss in shallow water areas.

A number of compressed air systems have proven successful in preventing ice from forming in relatively small areas of water. On Babine Lake in British Columbia one such system keeps a two-mile channel open throughout the winter although the temperature falls to minus 40 degrees and the ice averages two feet thick. Trials over a longer distance were successful in Sweden during the winter of 1957-58. The compressor stations were 12-14 km. apart but navigation was fast and easy throughout the winter, while other channels were impassable.

All of these trials have been run on relatively small areas of water and the results may not be applicable to the Seaway. After studying the compressed air systems and other proposals, the U. S. Army Corps of Engineers concluded:[5]

> Although compressed air and water circulation systems have proven effective for limited ice prevention at lock gates and other limited areas, none of these schemes appear to have practical worth when applied to the entire navigation system. The extent and character of ice fields in such areas as the head of St. Mary's River, in the vicinity of the Straits of Mackinac, and in other areas are such that de-icing appears impractical.

General Dodge of the U. S. Corps of Engineers points out that disturbing the ice formation in the St. Lawrence River above Montreal during the winter months raises other considerations. The St. Lawrence Seaway and Power Projects were designed to provide for the forming of an ice cover to insure the satisfactory winter operation of the system. Breaking up this ice could operate to the disadvantage of the power plants.[6]

It seems, therefore, that the technical problems associated with keeping the Seaway open year-round are at best formidable, and at worst insurmountable. While it is generally agreed that parts of the Seaway system, such as the Welland Canal, could operate year-round, we know very little about the economic feasibility of twelve-month operation of the entire Seaway. A recent report prepared for the U. S. Department of Transportation by EBS Management Consultants, Inc. (hereafter referred to as the EBS Report) did consider the Seaway expansion problem, and its findings are considered in the next section.[7]

SEAWAY EXPANSION

There exists general agreement among Seaway officials in the U. S. and Canada that Seaway traffic may be rapidly approaching the capacity of its existing facilities. The estimated capacity of 60 million tons will probably be reached in the late 1970s. With the recent completion of the Poe Lock, expansion discussion shifts to the Welland Canal and the St. Lawrence River sections of the System. Current interest is focused on the Welland, where both the U. S. and Canada are considering building a new canal to bypass the Niagara escarpment.

There are sixteen locks along the Seaway System, seven on the upper St. Lawrence, eight on the Welland Canal and one at Sault Ste. Marie. Any expansion of the Seaway capacity would involve pairing the existing locks at the Welland Canal and along the St. Lawrence River. Although these locks would be paired with locks of larger dimensions, unless the dimensions of the connecting channels were also increased, larger ships could still not use the Seaway. Twinning the locks would permit a greater number of vessels to traverse the Seaway immediately and enable the new, larger vessels to use the System in the future after channel improvements had been completed.

In 1968, an estimate of the capital cost of various lock-pairing alternatives described below was prepared by the U. S. Coast Guard with the assistance of the U. S. Army Corps of Engineers, the St. Lawrence Seaway Authority and the St. Lawrence Seaway Development Corporation. The Coast Guard's evaluation of the physical aspects of the lock-pairing was based on the following assumptions:[8]

1. On the upper St. Lawrence River, pairing of the locks would be accomplished by building seven new locks in the same approximate location as the existing locks.

2. Pairing of the eight-lock Welland Canal would be accomplished by building an entirely new canal with four

high-level lift locks. The economic evaluation of this new canal is based on cost estimates prepared for the so-called All American canal, which bypasses the Welland Canal. An economic feasibility study evaluating the proposed four-lock "Super Welland" Canal was probably not done due to political considerations.

3. At Sault Ste. Marie, there are presently four tandem locks in operation, two of which are of standard Seaway size or larger. The new Poe Lock can easily handle vessels up to 1000 feet long and 105 feet wide with a draft of 30 feet.[9]

Tables I through III contain relevant size and cost data for three alternative improvement programs considered in the U. S. Coast Guard and EBS reports:

Table I

Estimated Cost of Lock Pairing

	Lock Size	Capital Costs* (Millions of Dollars)
Alternative No. 1	1200' x 110' x 33'	1,697
Alternative No. 2	1400' x 125' x 34'	1,838
Alternative No. 3	1600' x 140' x 36'	1,933

* Not including interest charges during construction.

Source: U.S. Coast Guard, Report of Technical Subgroup-St. Lawrence Seaway Task Force, November 1968, as quoted in EBS Report, Table VI-2.

Table II

Channel Dimensions Associated with Alternative Lock Dimensions

	Channel Depth	Channel Width
Alternative No. 1	31'	600'
Alternative No. 2	32'	700'
Alternative No. 3	34'	800'

Source: U. S. Coast Guard, Report of Technical Subgroup-St. Lawrence Seaway Task Force, November 1968, as quoted in EBS Report, Table VI-3.

Table III

Estimated Cost of Enlarging Total Seaway System Dimensions

Capital Cost (Million $)

Element	Channel Depth		
	31'	32'	34'
Locks, Channels	2,950	3,307	4,402
Ports and Harbors	343	413	544
Total	3,293	3,720	4,946

Annual Costs

	Channel Depth		
	31'	32'	34'
Total	145.0	159.0	184.0

Source: U. S. Coast Guard, Report of Technical Subgroup-St. Lawrence Seaway Task Force, November 1968, as quoted in EBS Report, Table VI-5.

The current dimensions of the Seaway allow passage of vessels up to 730 feet long by 75 feet in beam. Alternative No.1 is the size of the Poe Lock, which can handle the 1000-foot vessels currently being built to haul iron ore from the Lake Superior mines. These are the minimum dimensions that the Coast Guard would consider in an expansion program. At these dimensions the Seaway could handle every cargo ship currently operating except the new deep-sea oil tankers. However, since the trend in ocean ships and lake vessels is clearly towards vessels of 1000 feet and longer, and because any Seaway expansion would set the limit on vessel size for perhaps the next fifty years, Alternatives 2 or 3 would be a more likely choice for the expanded Seaway dimensions.

These improvements would permit the new, larger lake and foreseeable ocean vessels to traverse the entire Seaway and load and unload at the principal lake ports. These new vessels when fully automated can achieve substantial reductions in the cost of transporting a ton of cargo. EBS has estimated in Table IV the rates these vessels would have to charge in 1980 in order to earn a reasonable rate of return to their owners under the three improvement alternatives. Their estimates illustrate the savings these improvements could effect - some rates would be reduced to one-half their current level.

Table IV

Present and Predicted Charges on Moving Coarse Grains on the Seaway System with Enlarged Dimensions

Commodity	O & D Movement	Cost Item	1966 Rate Structure	Present System	1980 Enlarged Dimensions Altern. #1	Altern. #2	Altern. #3
Wheat	Lakehead to Lower St. Law.	Vessel	$4.10	$4.56	$2.43	$2.23	$1.95
Corn	Chicago to Lower St. Law.	Vessel	$4.75	$5.31	$2.76	$2.52	$2.32
Soybeans	Chicago to Lower St. Law.	Vessel	$7.77	$8.73	$4.39	$3.99	$3.45
Corn	Toledo to Lower St. Law.	Vessel	$2.42	$2.98	$1.08	$1.05	$1.02
Soybeans	Toledo to Lower St. Law.	Vessel	$3.81	$4.77	$1.73	$1.67	$1.61

Source: EBS Report, Table VII-9

Despite these dramatic cost reductions made possible by an improved Seaway System, EBS concludes that such a project would be inadvisable. In their opinion the costs of the improvements would outweigh the value of the future benefits, using either a 25- or 50-year payoff period.[10] EBS correctly defines the benefits from a Seaway improvement program as the transportation costs saved on Seaway traffic plus port income generated by increased traffic at the lakes ports due to the improvements. However, because of their conclusions regarding diversion of coarse grain and general cargo traffic from the lake ports, EBA almost certainly underestimates the cost savings and port income. Their estimates are evaluated in detail in our study entitled "Overseas Shipping at Great Lakes Ports: Projections for the Future".[11]

ESTIMATING TOTAL BENEFITS OF EXTENDING SEASON UPON SEAWAY TRAFFIC

To obtain the total direct benefits of an extension of the shipping season, the unit benefits must be applied to the volume of traffic that is expected to be diverted to the Seaway because of the twelve-month-season. Changes in the volume of traffic in the Seaway's principal commodity groups - grain, general cargo, iron ore, coal and petroleum products - must be projected over the life of the new facilities. The problems associated with predicting these traffic changes are discussed in this section.

Grain

Grain has been one of the most important commodities shipped over the Seaway, accounting for nearly 30 per cent of the total tonnage in recent years. This is also the traffic which is most affected by the winter closing. Although practically all Canadian wheat, much of the U. S. wheat and almost all U. S. grown corn and soybeans can be exported most economically through the Seaway, the winter closing seems to prevent much of this potential traffic - particularly the U. S. grains - from being exported via the Seaway. Most Canadian wheat exports move through the Seaway in fall or are stored until the spring opening. With U. S. grain this is not the case. The Corps of Engineers has estimated that of the grain exported to Northern Europe from areas tributary to the Great Lakes ports, 82 percent of the wheat, 39 percent of the corn, and 30 percent of the soybeans were shipped over the Seaway in 1962-63.[12] The major reason that a significant amount of the U. S. wheat is not shipped via the Seaway is the winter closing. The present rail and barge price structure has also curtailed corn and soybean traffic somewhat, but the winter closing is probably a more important factor in preventing this traffic from reaching its full potential. Since most observers believe that corn and soybeans are destined to become increasingly important export commodities in future years, one could expect these two grains to account for the major share of the increase in grain traffic brought about by an extended Seaway season.

A recent innovation in grain transportation on the Great Lakes-Seaway system that promises to be a major impetus to increased grain traffic over the Seaway is the development of a balanced, two-way cargo haul for the large lake ore carriers. Initially, grain movement through the Seaway was mostly direct overseas shipments via medium-sized ocean bulk carriers, but in recent years grain has begun to be hauled in large lakers to lower St. Lawrence River ports and then overseas in large ocean carriers. The lakers haul Labrador iron ore on their return trip. This balanced grain-ore movement has increased the efficiency of the large lake bulk vessels and has introduced substantial economies in transporting grain via the Seaway. Because these economies are substantial, this traffic is expected to grow rapidly. Several U. S. firms are presently building large grain elevators on the lower St. Lawrence to handle future U. S. exports of feed grains.[13]

The economies of this new pattern of grain traffic will undoubtedly make the Seaway even more attractive to grain shippers, especially if the Seaway season is extended and harbors improved to handle the large lakers. Because this innovation is still in its infancy, its effect on future grain movements via the Seaway will be difficult to judge. With this development, however, an extended shipping season would probably mean a major increase in feed grain traffic (principally corn and soybeans), which would substantially increase the benefits of extending the shipping season.

In addition to transportation costs saved by diverting grain to the Seaway, the reduction in storage costs also represents benefits accruing to an extended navigation season.

To quantify these benefits one must estimate what the annual costs of storing export grain over the winter will be if the Seaway season is not extended. These savings of storage costs should be net benefits, since one assumes that the grain would not be stored over the winter if shipping it by rail to a coastal port is a cheaper alternative. If, however, political or other considerations not related to transport costs enter into this decision, they must be considered and the benefits attributed to reductions in storage costs must be reduced accordingly.

General Cargo

Along with grain, general cargo shipments over the Seaway should be importantly affected by an extension of the shipping season. Forecasting the increase in general cargo traffic promises to be more difficult, however, because factors besides the winter closedown - such as frequency of sailings, time in transit, and force of habit - play an important role in determining the routing of these high value exports. General cargo traffic is not as sensitive to transportation cost differentials as bulk commodities; therefore one cannot assume that most of this cargo now moving to coastal ports during the winter months would move via the Seaway if it were open.

It is clear, however, that the winter closing is hampering the growth of general cargo traffic on the Seaway. Many exporters are reluctant to deal with two shipping services, as they must if they ship from a lake port in summer and an ocean port during the winter. They feel that they receive better and cheaper service if they concentrate all their business with one forwarder. The problem of infrequent sailings into the lakes may be alleviated somewhat if ship owners know that they can use the Lakes-Seaway route year-round. For these reasons year-around Seaway operations may mean as much as a one-third increase in general cargo traffic as more midwestern exporters divert all of their general cargo traffic to lake ports.

Another difficulty in measuring the benefits due to increased general cargo traffic is that measuring the unit cost savings will be more difficult than for grain. The term general cargo covers a broad variety of commodities - from tractors to wine - which will have different alternative transport modes as well as rates. Determination of the cost differentials becomes more difficult because trucks are the least cost alternative for much general cargo and railroad for the rest. The multiplicity of rates charged by truckers and railroads must be examined and adjusted to make them conform to marginal costs.

Finally, transportation innovations such as the development of the new jumbo jet planes which will reduce the cost of shipping general cargo by air and the expansion of the use of containers on more ocean routes, may have important effects upon future Seaway general cargo traffic.[14]

All of these factors must be considered when forecasting general cargo traffic and cost savings over an extended shipping season. Taken together they make the estimation of future benefits generated by increased general cargo traffic the most tenuous part of any analysis.

Externalities

In addition to the direct benefits of an extended season, indirect or external benefits, i.e., benefits not directly measured as reduced transport costs, can also be included in total benefits if they meet our criteria of saving economic resources. Economists disagree over the type of externalities that can legitimately be included in total benefits. Those who adhere to the narrow definition of benefits would exclude any purely monetary benefits such as competitive reductions in rail, trucking or barge rates. They contend that these reductions cannot be attributed to the investment in the waterway because an efficient regulatory agency would have forced these rate reductions even without the new competition from the waterway. While this view is theoretically indisputable, we know that regulatory agencies, especially the ICC, are notoriously inefficient at achieving railroad rates that reflect costs and that a great deal of price discrimination exists in the market for transporation services. One may, therefore, want to include in total benefits any competitive rate reductions induced by the project even though they are not strictly speaking economic benefits, since they entail a redistribution of income rather than a reduction in real costs.

In measuring these benefits for a specific project such as extending the Seaway season, one must show that railroads, truckers or barge operators would lower their rates in response to an extension of the season. While such rate reductions did follow the opening of the Seaway,[15] it is not so apparent that they would occur if the Seaway season were extended.

Other external benefits which do involve savings in real costs and would, therefore, be included under the strictest definition of benefits would be reduced inventory and storage costs of some bulk commodities and reductions in ship operating costs. Iron ore traffic would probably not increase significantly if the Seaway season were extended; rather the existing traffic would be spread over a twelve-month period instead of the present eight months. Benefits to the ore users would take the form of reduced storage costs, while ship owners would enjoy more efficient utilization of their vessels, which would no longer have to lay over for four months each year. These same benefits would accrue to shippers and users of other bulk commodities such as petroleum products, coal and salt. Quantification of these benefits would involve estimating annual storage costs saved plus taking the per ton reduction in vessel costs times the total tonnage hauled per year.

A final externality that should be considered is the more efficient utilization of Seaway and port facilities made possible by their year-round operation. As always, one must be careful not to double-count these benefits. Some of them will show up as reduced shipping costs (and will be measured as such) if ports are able to lower average costs as they spread their fixed costs over a longer season and over more tonnage. Others may not directly affect transport charges. These would include the delaying of congestion-induced expansion of Seaway and port facilities. While traffic such as iron ore will not increase in volume after the season has been extended, it will be spread over twelve months rather than eight, thus relieving possible congestion. As Seaway tonnage approaches the present capacity of the locks, elimination of some of the congestion of these facilities and perhaps of some port facilities takes on added importance as an external benefit according to an extension of the Seaway season.

CONCLUSION

The winter closedown of the St. Lawrence Seaway obviously increases operation costs of the Seaway. Ships must be redeployed or laid up for one-third year. Investment in lake vessels and in port facilities must be allocated over eight rather than twelve months. Many employees in port-related occupations must be idled, relocated or supported through the winter. Recruiting and retraining of employees, re-selling shipping services, preparing ships for winter idleness and for re-use in spring, and other annual startup and closedown costs can be quite substantial.

As obvious as these costs are *a priori*, they have not been sufficiently studied and quantified. Until we have more precise information on cost reductions, on the cost of extending the Seaway season, and on the expected changes in traffic over the Seaway, we can only conclude that the extension of the season would be difficult and expensive and that it would generate additional Seaway traffic, principally for grain and general cargo traffic.

Aside from these very general conclusions, this preliminary study has suggested a number of questions that must be considered in any definitive study of the feasibility of extending the Seaway navigation season. The first, and obvious, question is whether an extension of the season or year-round operation of the Seaway is technically possible. General Dodge of the U. S. Corps of Engineers has questioned whether year-round navigation on the Seaway is possible.[16] A detailed engineering study must be undertaken to determine if and how the Seaway season can be extended.

The cost of extending the shipping season has not been completely estimated, and is discussed in our "Overseas Shipping at Great Lakes Ports: Projections for the Future" investigation. A complete study of the cost is basic to the analysis of the economic feasibility of keeping the Seaway open longer or throughout the winter.

Finally, the most difficult questions relate to the expected benefits of an extended Seaway season. What will be the magnitude of the cost reductions enjoyed by the owners of lake and ocean vessels and by the shippers whose cargo is transported most economically via the Great Lakes and the Seaway? How much more grain can we expect to move through the Seaway over the longer season? Although EBS estimated that a four-week extension of the season would mean a significant increase in general cargo tonnage, this conclusion is at best preliminary. What type of season extension is required to induce ship owners to schedule more sailings into the Great Lakes? Perhaps a twelve-month shipping season is necessary before many exporters will reroute their general cargo traffic through the Seaway. Little is known about what is required to change the shipping habits of midwest exporters who presently ship about 10 percent of their general cargo through the Seaway (18 percent when measured in value). These questions are basic to the analysis and need to be considered carefully and completely.

It is discouraging to end a study with the conclusion that what is required is more study; however, in this preliminary investigation that conclusion has followed logically. In attempting to explore the problem of extending the Seaway season, the researcher is presently limited by the dearth of good, usable data and information. While we have presented a brief and very general discussion of some of the expected results of an extension of the Seaway season, a thorough technical and economic analysis encompassing the questions raised by this discussion seems to be the first prerequisite to an investigation into the feasibility of extending the navigation season on the St. Lawrence Seaway.

FOOTNOTES

1. Eric Schenker, The Port of Milwaukee, An Economic Review, University of Wisconsin Press, Madison, Wisconsin, 1967, Chapter 9.

2. U.S. Coast Guard, Report of Technical Subgroup-St. Lawrence Seaway Task Force, November 1968. EBS Management Consultants, Inc. An Economic Analysis of Improvement Alternatives to the St. Lawrence Seaway System, January 1969.

3. Brigadier General Roy T. Dodge, "Ice Breaking for an Extended Navigation Season for Overseas Traffic Through the St. Lawrence Seaway and the Lower Great Lakes", October 1964, p. 2.

4. The St. Lawrence Seaway Authority, "The Seaway's Problems Relative to Extending the Season Beyond November 30", September 1965, p. 7.

5. Dodge, op. cit., p. 5.

6. Ibid.

7. EBS Report, op. cit.

8. U. S. Coast Guard, op. cit.

9. EBS Report, op. cit., pp. VI 2-3.

10. Ibid., Chapter VI.

11. Eric Schenker and James Kochan, Overseas Shipping at Great Lakes Ports: Projections for the Future, Center for Great Lakes Studies, University of Wisconsin, Milwaukee, 1970, Chapter IV.

12. U. S. Army Corps of Engineers, Grain Traffic Analysis, 1965.

13. G.V. Sainsbury, "Bulk Cargo Traffic in the St. Lawrence Seaway", in Writings on Canadian-American Studies, John L. Hazard ed., Michigan State University, 1968, p. 84.

14. Eric Schenker, "The Effect of Containerization on Great Lakes Ports", Center for Great Lakes Studies, University of Wisconsin, Milwaukee, 1968.

15. Carl J. Lessing testimony before the U.S. Senate Committee on Public Works, August 30, 1967. Lessing cites as an example of perverse railroad rates, the rates charged for wheat shipped to Northwest Pacific Coast ports. A 90¢ rate applies to shipments originating in Montana while a 70¢ rate applies to shipments from North Dakota.

16. Dodge, op. cit.