GREAT LAKES SHIPPING AND CLEAN AIR: INTERACTIONS

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CLEANER AIR OR HEALTHY LAKES—A TRADE-OFF?

The **U.S.** clean air standards have caused many electric utilities to shift to cleaner western coals. Much of this western coal is shipped in part by way of the Great Lakes. **As** these coal shipments increase, they put pressure on the existing carrying capacity of the U.S.-Flag Fleet on the Great Lakes. Our forecasts suggest that demand will exceed carrying capacity by **4** percent or more by the year 2000. **As** a result, there could be renewed political pressure to extend the shipping season into the winter lay-up period. This means that the attempts to further improve air quality could lead to unforeseen environmental impacts on the waters of the Great Lakes. The Great Lakes system in winter **is** fragile. Biologists are concerned that the passage of large lake ships through ice-covered narrows and shallows may disturb vital fish beds and the reproductive cycle of other critical organisms in the lakes.

In January 1996, the **U.S.** Corps of Engineers, as the agency in charge, proposed fixed dates for opening and closing the key locks at Sault Ste. Marie' of March 25 for opening and January 15 for closing each year (***U.S. Federal Register** 2* January 1996). These fixed dates not only provide a

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[2] The locks at Sault Ste. Marie, Michigan (USA) and Ontario (Canada). known as the Soo Locks, are at the eastern end of Lake Superior where it meets Lake Huron.

longer shipping season than previously established, they also give the assurance of specifically set dates. Our analysis of ship capacity and potential demand suggests, however, that even this somewhat longer shipping season will not be adequate to meet demand by the year 2000.

This paper documents the increased demand for shipping expected by the year 2000 and lists the previous studies of environmental impacts from winter navigation on the Great Lakes.

Recent Shipping Demands Add Pressure

Trying to protect the Great Lakes and meet clean air standards pose a serious dilemma. Recent statements from government news releases and trade journals may help to put this dilemma into context.

"Coal deliveries to electric utilities hit record levels [in 1994]," read one headline in the U.S. Energy Information Administration ***News Releases*** (EIA July/August 1995: 4). But this record was short lived, as 1995 utility coal use exceeded 1994 levels and the forecast for 1996 was higher yet. **As *Skillings Mining Review*** (2 March 1996: 4) reported, "Utility coal use continues to set records, increasing to **an** expected 839 million net tons in 1996, as compared with 824 million net tons in 1995 and 817 million net tons in 1994."

This trend of record-breaking coal sales resulted in large pan because "utilities continued to increase their use of low-cost subbituminous coal from the Powder River Basin in Wyoming and Montana" (EIA July/August 1995: 4). "In 1995, Midwest Energy Resources Co. in Superior, Wisconsin, established a new record in the 20th year of operating the largest Great Lakes coal terminal, with transshipments totaling 13,474,121 net tons of low-sulfur western coal" (David Skillings 1996). And, "When the Soo Locks closed on January **15** [1996], steelmakers needed so much iron ore that a record number of ships were routed to Escanaba, [the main shipping port south of the Soo Locks]....U.S.-Flag lakers continued to load at Escanaba until February 14, making the 1995 season the longest on record" (Ryan 1996: **3),** apart from the experimental period in the 1970s when year-round navigation was tested.

The overall demand in 1996 for U.S-Flag dry bulk carriers on the Great Lakes, the only ships that may transport coal, iron ore, and other bulk commodities from one **U.S.** port to another U.S. port, reached 95.8 percent of its capacity, as measured by the Lake Carriers Association (Lake Carriers Association 1995). During the 1996 shipping season, the Lake Carriers Association reported that "U.S.-Flag carriers hauled...the highest level since the recession of the early and mid-1980s [exceeding] the previous peak...of 1994" (***Skillings** Mining **Review*** 15 March 1997: *25)*.

As these published statements indicate, the pressure to increase shipping is intense.

Three Options: Longer Season, All Rail, or More Ships

There are three ways to meet the increasing demand for Great Lakes shipping. One is to break more ice and lengthen the shipping season even further into the environmentally fragile winter. Another is to build more large, U.S.-Flag bulk carriers, probably in the 1000-foot class. And third is to transport more of the western coal by all-rail means to Detroit Edison and other major Midwestern utilities.

In terms of direct economic costs, lengthening the shipping season is the least expensive. Both of the other two options are more expensive, although it is hard to tell which of them is more costly because their economics change greatly with their operating or use rates. All-rail transport is certainly more flexible in terms of use of equipment. Therefore, expanded use of rail will probably be relied upon until the demand reaches a high and sustained level that justifies full use of another 1000-foot dry bulk carrier throughout the shipping season.

That means as shipping demand rises, pressure will first come to lengthen the shipping season. Although any extra demand can now be moved by rail, rail is more expensive than lake shipping. When demand has been sustained at roughly **3.0** to *3.5* million long tons per year over current capacity, a new 1000-footer could be justified. Our analysis suggests that demand will exceed ship capacity by 4-5 million long tons in the year *2000*.

Longer shipping season debated for years

The length of the shipping season has been debated for many years. George Ryan, president of the Lake Carriers Association, wrote in the 1995 LCA ***Annual Report,*** "The debate over the length of the shipping season began in 1970....[finally] we apparently have reached resolution. It's **a** compromise. Some **LCA** members and some of their customers wanted a longer season.

Some environmentalists wanted a shorter season" (Ryan 1996: *5)*. The compromise was the slightly longer shipping season and firm dates.

Historically, the Soo Locks opened in early to mid-April and closed on December 15 or shortly thereafter. These opening and closing dates were weather-related, but not entirely because of navigation concerns. Until the late 1950s, most iron ore was mined and shipped in its natural state. This so-called "red ore" or "naturally concentrated ore" had such a high moisture content that it quickly froze in rail cars, on shipping docks, or in the cargo holds of vessels in the winter. A mid-March to mid-February navigation season for the iron ore trade was unthinkable while red ore dominated the Lakes.

In the mid-1950s, a different ore began to be mined. Low-grade taconite ore was crushed, ground, concentrated, and rolled into blueberry-size pellets that were kiln-hardened. This pelletized iron ore can be transported throughout the year. As shipments of taconite pellets increased, industry began to push for longer and longer shipping seasons.

In the 1970s, the steel and shipping industries, along with the federal government, participated in a demonstration program for winter navigation through the Soo Locks. A full 12-month season was actually achieved for five years. Despite its technical feasibility, year-round navigation was not established permanently, primarily because of concerns about its potential impacts on the Great Lakes environment. A secondary concern was the economics of mid-winter navigation. For many years, therefore, a shipping season of roughly 9% months was followed. The actual closing date in January was determined by both the needs of commerce and a formula involving freezing degree-days. The locks were generally closed from January **8** (plus or minus one week) to April 1.

Recently, however, the continued strong demand for iron ore and increased demand for western coal brought the renewed pressure to lengthen the shipping season. Therefore, after years of debate, the U.S. Army Corps of Engineers proposed the current fixed dates for opening the Soo Locks on March 25 and closing them on January 15 (U.S. Federal Register ***2*** January 1996).

The Clean Air Act and Coal

Coal is America's most cost effective source of thermal energy. It is directly responsible for setting modern households free from many mundane tasks of daily existence. Coal is marvelously available, cheap, safe, and abundant. But it can also be dirty.

The most recent and significant effort to regulate coal burning in the United States is Title IV of the 1990 revision/renewal of the Clean Air Act, known as the acid rain provision. This is a complex two-phase program that regulates stationary emission sources and imposes limits on emissions that cause acid rain. Eighty percent of these sources are coal-fired electrical. power generation facilities. Central to the strategy of both phases is low-sulfur coal.

Coal accounts for a greater share of the U.S. primary energy production than any other fuel, having surpassed petroleum in 1984. Coal's share of total U.S. energy production is estimated to rise through the end of this decade, and the Energy Information Administration (EIA) projects that 75 percent of the 169 gigawatts needed for new base-capacity after 2000 will be coal-fired.

Coal from the Powder River Basin (PRB) in Wyoming and Montana is low in sulfur content and has very low extraction costs. It is also available in extremely large quantities. At under $5 per ton FOB–mine, PRB coal is very competitive on a delivered basis in many areas east of the Mississippi, and particularly in the Great Lakes region.

Shipping coal

On average, 10 to 14 million net tons of western coal are shipped annually through the Superior Midwest Energy Resources Corporation (MERC) terminal at the Duluth/Superior Upper Lakes port to Lower Lakes utilities. At the present time, at least three 1,000-foot lake boats are dedicated to this task. As utilities respond to clean air act compliance requirements, water-borne coal demand could increase to as much as 20 million tons per year by the end of the decade (Ethan 1992).

As early as March 1991, George Ryan, president of the Lake Carriers Association, predicted that by the year 2000, "...two or three new 1,000-foot coal carriers will be needed to move western coal" (*Seaway Review* 1991). In a February 1992 address to the Lake Carriers Association, John Ethan, president of Superior Midwest Energy Resources (MERC), reiterated this concern indicating that depending on the movement of other commodities on the Great Lakes, a vessel capacity problem for 1,000-foot vessels could exist in the near future.[3]

We have restricted our analysis to U.S.-Flag dry bulk carriers, which carried 66 percent of all bulk commerce on the Great Lakes in 1995, because:

1. The Merchant Marine Act of 1920, commonly known as the Jones Act, requires all commodities shipped from a U.S. port to a U.S. port to be transported in vessels built in the U.S. and staffed with U.S. citizens. Almost all of the western coal and most of the iron ore from Minnesota and Michigan is transported to U.S. Lower Lake ports and thus requires U.S.-Flag vessels.

2. The two other major bulk commodities transported on the Great Lakes are cement and liquid bulk (mostly petroleum products) and they have their own dedicated ships which include some additional U.S.-Flag vessels. These ships tend to be smaller and cannot easily be converted to handling other dry bulk cargoes. In addition, the demand for cement and liquid bulk trade is close to full capacity itself.

3. To accommodate increased western coal demand, the next ship to be built will probably be a 1,000-footer (that is, of the largest, most modem class to sail the Great Lakes). Each 1,000-footer can carry the equivalent of six 100-car trains, with each car carrying 100 tons of coal. These ships are too large to get out through the Welland Canal and thus are locked into the upper Great Lakes where they go primarily between U.S. ports.[4] There are 13 1,000-footers today. **All** of them are part of the U.S.-Flag Fleet; none is Canadian.

Emissions reduction options

The eight-state East–North Central (ENC) coal consumption region is the largest user of utility coal in the United States. Its share of the nation's total

[3] Since **1984** the Superior (Wisconsin) Midwest Energy Resources Corporation has been the largest volume coal port on the Great Lakes.

[4] The upper Great Lakes are Superior, Michigan. Huron. and Erie. The Welland Canal connects Lakes Erie and Ontario.

is about 33 percent. ENC is composed of Wisconsin, Illinois, Indiana, Kentucky, West Virginia, western Pennsylvania, Ohio, and Michigan. Low-sulfur western coal is supplied to this region by rail and water. Because of its low cost, western coal is expected to play a major role in allowing midwestern electric utilities to meet Phase I and Phase II compliance requirements. Compliance strategies will in part require replacing an undetermined amount of currently used high-sulfur coals from the Appalachian and interior regions with low-sulfur western coal.

In all, there are five or six basic options that utilities can exercise when deciding their fuel and emissions mix. The new clean air act rules allow each utility to make the decision as to which mix of options to employ. Those who can, may choose to receive low-sulfur coal by water or rail. Others may stay with scrubbers in order to preserve local coal mining jobs. Some may switch to natural gas-fired boilers. Others may develop a combustible blend of high- and low-sulfur coal. Still others may choose to do nothing at all except purchase additional emissions allowances from cleaner competitors (a worrisome feature of the clean air act amendments for downwind states). A sixth possibility that currently looms large is deregulation. Deregulation will pit local utilities against more distant suppliers who can suddenly “wheel” power into the local, previously captive markets at a lower rate.

Future Coal Consumption

Forecasting coal consumption patterns through the end of the decade depends heavily on both the rate of economic growth and the compliance choices made by utilities. Each choice is extremely sensitive to price, particularly the effects of transportation costs that can cause different compliance strategies to come within pennies of each other. At a certain point, it makes economic sense for a utility to install costly scrubbers rather than pay the price of shipping low-sulfur coal from distant regions.

We examine various government and industry forecasts of shipping coal, iron ore, and limestone on the Great Lakes to the year 2000 and compare total demand to current U.S. bulk fleet carrying capacity. Current shipping capacity is very tight and is expected to have even more pressure on it by the year 2000. Since the summer 1994, all of the economically feasible U.S. Great Lakes Flag fleet capacity was in use.

In addition to coal demand, forecast values have also been examined for iron ore and limestone consumption, as well as the potential for moving new bulk commodities in the Great Lakes basin for the next decade. The forecast values used are the result of numerous conversations with sources in industry, academia, and state regulatory agencies. We have developed a number of scenarios, but for this analysis we have chosen to present the one highly dependent on the U.S. steel industry demand forecast generated by PaineWebber's *World Steel Dynamics* research unit (Marcus and Kirsis March 1996).

FORECASTING CONSIDERATIONS

Far more low-sulfur coal exists in the Powder River Basin (PRB) than in Appalachia. Total Appalachian low-sulfur recoverable reserves are approximately 12 billion tons, compared to Wyoming's 68 billion and Montana's 120 billion tons. PRB coal is much more accessible, but transportation costs play the pivotal role in determining delivered price per ton.

Because it is low in BTU content, western coal is not used for metallurgical purposes, but it is well suited to generate steam for the production of cleaner electricity. After the Clean Air Act of 1970 was implemented, increasing amounts of low-sulfur western coal were shipped to midwestern utilities. Between 1970 and 1990, the use of western coal increased at an average rate of 12 percent per year compared with rates of less than 1 percent for Appalachia and less than 2 percent for the interior region. In 1990 nearly one-third of the nation's coal production came from western mines compared with only 6 percent 20 years earlier (EIA 1992).

Trends

Historically, Lake Erie ports have always led the Great Lakes in U.S.-Flag coal shipments. This was so until 1987 when, for the first time, Lake Superior shipments exceeded Lake Erie shipments. Table 1 depicts this trend for the past eight years. Detroit Edison is by far the largest single consumer of waterborne Great Lakes western coal. It is Edison's determination to lower SO_2 emissions that accounts for most of the shift from high-sulfur Appalachian coal to low-sulfur western coal. Edison's experience has shown that when western and eastern coals are blended, it is possible to achieve emissions compliance at lowered costs and without retrofitting.

Out **of** this experience a very substantial interest in blending has developed at four coal-handling ports on the Lower Lakes in addition to MERC facility located in Superior, Wisconsin. These are Burns Harbor, Indiana; Toledo, Ohio; Conneaut, Ohio; and Buffalo, New York. **A** market analysis done for Resource Data International, Inc., indicated that in 1995, a potential of 19.4 million tons of blended coal existed for these facilities, with the year 2000 having a potential of 40.7 million tons of blended coal.

Table **7. U.S.- Flag coal shipments (million net tons/yr.)**

Year	Total coal	Erie	Superior
1985	19.3	12.3	7.0
1986	20.5	12.3	8.2
1987	19.9	8.7	11.2
1988	18.3	8.4	9.9
1989	19.5	8.0	11.5
1990	19.9	8.0	11.9
1991	18.6	7.2	11.4
1992	18.8	8.0	10.8
1993	19.5	8.3	11.2
1994	23.1	10.1	13.0
1995	21.3	8.5	12.8

Source: Lake Carriers Association annual reports

Utility Considerations

To enjoy the large economic advantage of waterborne shipping over rail shipping, midwestern utilities must be sited on the lakeside. Transshipment costs from rail **to** vessel at the head of the lakes is $2.00 to **$2.25** per ton (Ethan 1993) and it would be at least this much again for a midwestern utility to transship to an inland destination. Thus, only those utilities with generating units situated directly on the Great Lakes or their waterways can economically receive western coal by water.

At roughly 12 million tons per year, Michigan is the largest consumer of western waterborne coal. Wisconsin Power and Light is second at one million tons. Currently, neither New York, Pennsylvania, nor Indiana coal-fired units have plans to use any western coal. Ohio has just begun to receive a modest amount.

For coal, four growth rates have been suggested: EIA, 1 percent; National **Coal** Association, *2* percent; MERC, 9.2 percent to 14 percent. Growth of I percent to *2* percent is of little consequence in this study, since western coal growth is increasing at the higher rates and it is likely to expand at the expense of Lake Erie haulage. This is especially true following the 1995 Phase I regulations. We have considered an increasing substitution of western coal for Lake Erie (Appalachian) coal based on our general industrial demand forecast. As a result, we believe Lake Erie coal shipments will remain nearly constant while western coal could increase from approximately 12.8 million net tons in 1995 to an estimated 15.3 million by the year 2000 (see table *2).* This represents a modest growth rate of 3.5 percent per year on average.

Table 2. **Projected increase of western coal in US-Flag vessels on Great Lakes** (millions **of** net tons)

ANNUAL RATES OF INCREASE

	7.5%	**10.0%**	**13.0%**	**With cyclical impacts**
1994 Actual	13.0	13.0	13.0	13.0
1995 Actual	12.8	12.8	12.8	12.8
1996 *e*	13.8	14.1	14.5	12.6
1997 e	14.8	15.5	16.3	13.7
1998 e	15.9	17.0	**18.5**	14.0
1999 e	17.1	18.7	20.9	14.5
2000 e	18.4	20.6	23.6	15.3

Iron Ore

For over 100 years, the largest bulk commodity **on** the Lakes has been iron ore which has accounted for more than 50 percent of all cargo carried by U.S.-Flag lakers. Cyclical highs and lows have been characteristic of annual bulk tonnage, but until the upheavals of the 1980s the iron ore industry had experienced 25 years of fairly steady growth. In 1979 the ore float topped 106 million tons (Kakela 1993).

In 1982, the bottom fell out for iron ore. The national economic recession was coupled with strong substitution of plastics and aluminum for iron and steel as well as fierce foreign competition. This led to the painful downsizing of the North American iron ore industry. Growth throughout the 1970s had produced a serious overcapacity in the domestic iron ore industry. In the following decade, between 1980 and 1988, 55 percent of iron mining jobs were lost and 41 percent of U.S. iron ore pellet capacity was eliminated as mines and mills aggressively restructured to become world competitive once again (Kakela 1993).

The heroic cost reduction efforts by domestic ore and steel producers paid off. The challenges of the 1980s were met by increasing productivity while reducing excess capacity and manpower. As a result, demand for domestic iron ore pellets eventually stabilized, then grew slightly at the end of the 1980s and is continuing strong in the mid-1990s.

The forecast is for iron ore demand to remain strong through 1998 before dropping off in 1999. A rebound is expected in the year 2000. Increases in pellet production translate directly into increases in demand for vessel capacity.

The expected drop in demand in 1999 is more than a cyclical variation; it represents a reduction in pellet demand as a result of the impact of advancing minimill technology in the United States. As minimills becoming progressively more efficient at producing high-quality flat-rolled thin-slab steel from scrap, they will encroach ever more into the historic market of the integrated steel mills. Total demand for raw steel is not expected to decrease, but minimill recycling of scrap is expected to account for more of the domestic demand. If the minimills can reduce the amount of imported steel coming into the U.S., demand for domestic iron ore could remain strong. There could also be a shift in iron ore sourcing from eastern Canada to Minnesota and Michigan mines. Long-term contracts at the Iron Ore Co. of Canada terminate in December 1999, and certain American steel company partners could shift to domestic sources. Therefore, by the year 2000 iron ore capacity is expected to rebound to match and even exceed the current high levels (Kakela 1996).

Limestone

Limestone is an essential commodity in modem life, not only going into highways and sidewalks, but also as a basic component of the steelmaking process. In this sense, limestone is a part of every refrigerator, bridge, high-rise, and automobile. Limestone is a highly regional commodity in that trucking costs limit distribution to about 30 miles. For example, it is cheaper to ship limestone 300 miles form Port Inland in the U.P. to Detroit than it is to truck limestone 60 miles from Toledo to Detroit (Siekierski 1993).

Another use of limestone is for smokestack scrubbing as a way of meeting Phase I and II sulfur emissions requirements. Two and a half tons of limestone are required to remove one ton of sulfur. With a total reduction requirement of 10 million tons by 2000, 12.5 million tons of limestone would be required to scrub away even half of the 10 million tons. Industry specialists indicate that Phase I requirements have not caused much increase in scrubber technology use. Impact of Phase II requirements are still too far off to make adequate predictions. As other technologies such as fluidized bed combustion become cost competitive, however, the demand for limestone will increase. And, with the recent passage by Congress of a highway bill and other proposed construction stimulus packages, non-metallurgical uses for limestone could burgeon. Industry personnel expect increased reliance on crushed limestone for construction filler as a result of shortage of new supplies of gravel.

Waterborne limestone is price competitive only if final destination is less than *30* miles from the port of delivery. The Great Lakes limestone industry has a capacity of 33.5 million tons per year. Some shipping experts, however, do not expect demand to rise above 1988–98 levels by the year 2000, unless shipping capacity increases to accommodate a larger steel industry (see table 3).

Fluxed pellet production and limestone consumption

Beginning in 1987, mines in Minnesota and northern Michigan began making fluxed iron ore pellets with limestone at the mine sites rather than at the steel mills on the Lower Lakes. This fluxing process bums off about half the limestone and what remains becomes added to downbound cargo weight. In essence, then, half of this stone is shipped twice (Beck 1991 a,b).

In 1996 about 15 percent of the total limestone shipment went to produce the 55 percent of iron ore pellets that were fluxed. Some experts believe that in the next several years there may be a market for 75 to 80 percent of all pellets to be fluxed. This would result in a 5 to 10 percent increase in total limestone shipment with half of this increase being transported twice.

Table 3. **United States iron ore pellet capacity, production, and operating rates** (millions **of** LTP/yr)

Years	Effective pellet capacity	Pellet prod'n	Operating rates %	US-Flag shipments (long T)	US-Flag shipments (net T)
1979	92.4	77.1	83.5%	78.6	88.0
1980	93.5	64.1	68.5%	62.5	70.0
1981	88.4	70.0	79.2%	63.4	71.0
1982	85.4	32.9	38.6%	32.1	36.0
1983	74.3	36.0	48.4%	42.9	48.0
1984	69.7	49.9	71.5%	46.4	52.0
1985	63.6	46.8	73.5%	43.3	48.5
1986	60.2	36.7	61.0%	38.8	43.5
1987	56.7	45.0	79.4%	48.2	54.0
1988	55.4	54.7	98.8%	54.2	60.7
1989	57.7	56.2	97.4%	51.0	57.1
1990	62.3	53.3	85.5%	53.2	59.6
1991	61.0	53.5	87.8%	49.0	54.9
1992	61.5	53.6	87.3%	50.5	56.6
1993	59.9	53.6	89.5%	51.4	57.6
1994	58.6	56.6	96.5%	52.3	58.6
1995	63.4	60.6	95.6%	52.9	59.3
1996p	64.2	62.7	97.7%	54.2	60.6
1997f	64.7	61.7	95.4%	54.2	60.6
1998f	64.7	63.1	97.5%	55.6	62.2
1999f	65.9	58.9	89.4%	51.4	57.6
2000f	69.2	63.9	92.3%	56.4	63.1

Source: P. Marcus, K. Kirsis, and P. Kakela. "North American iron ore: strong demand doesn't provoke capacity increases." ***World Steel Dynamics Monitor Report.*** New York: PaineWebber. (Updated to February 1997 by Peter Kakela.)

Sand, Salt, and Grain

The other dry bulk commodities are sand, salt, and grain. The combined four-year average of sand, salt, and grain is 2.2 million net tons annually. This is assumed to be a constant amount throughout the forecast period. Total dry bulk composite is depicted in table 4.

Table 4. **Estimated limestone tonnage through *2000***
(million net tons)

ACTUAL Year		EST. Year	Annual growth rate 2.6%	Annual growth rate 10%	
1985	19.6				
1986	19.1	1995	25.8	25.8	
1987	23.9	1996e	26.5	28.4	
1988	26.4	1997e	27.2	31.2	
1989	25.1	1998e	27.9	33.5*	(34.3)
1990	23.4	1999e	28.6	33.5*	(37.8)
1991	22.2	2000e	29.4	33.5*	(41.6)
1992	20.0				
1993	22.2				
1994	24.5				
1995	25.8				

***Industry** capacity

Based on Lake Carriers Association Annual Reports

U.S.-FLAG FLEET DRY BULK CAPACITY

In the 1970s, various U.S. Great Lakes Flag shippers launched a major new construction program. At the start, the U.S.-Flag fleet was composed of 240 vessels. Combined trip capacity was 2.8 million gross tons and average per-vessel carrying capacity was a mere 11,713 tons.

In 1969 the Poe Lock opened at the Soo. It was the largest lock to date and accommodated the 1,000-foot ships. To capitalize on the economies of scale that the Poe Lock allowed, and driven by a booming iron ore trade throughout the 1970s, 13 1,000-foot self-unloading ships were built between 1972 and 1981. These super-ships have per-trip carrying capacities of 52,000 to 62,200 gross tons. And **as** these ships began to dominate the Great Lakes bulk cargo trade, many of the smaller, less efficient vessels were scrapped. By 1981, the U.S.-Flag fleet dry bulk carrier count was down to just 135 vessels.

Then the 1982 recession hit. Between 1982 and 1987, 52 vessels were slashed from LCA's rolls. Only the large, self-unloading vessels survived. The standby fleet shrank to virtually nothing, with just two, small, non-self-unloading straight-deckers remaining.

In 1996, the U.S.-Flag fleet had 61 vessels, ***52*** of which haul dry bulk cargo. Total dry bulk carrying capacity was 1.9 million net tons, with an average vessel capacity of around 37,106 net tons (Lake Carriers Association 1996). (See tables ***5*** and **6.)**

The significance of the 1,000-footers cannot be overemphasized. To illustrate their economy of scale, which was made possible by the Poe Lock, consider that the largest non-Poe class vessel requires 2% voyages to equal the hauling power of a single 1,000-footer.

There have been no new 1,000-foot vessels built for the Lakes trade since 1981 when the last 13 1,000-foot super-carriers were delivered. Nor have shipping companies announced plans to build additional 1,000-footers. LCA President George Ryan believes an additional three million tons of cargo capacity are permanently needed before real planning for a new 1,000-footer will begin *(Seaway Review* 1991).

Conclusions

Total available U.S.-Flag Fleet dry bulk capacity in 1996 was 114.6 million net tons, whereas shipments totaled 109.9 million net tons. This represents **a** 95.8 percent use of capacity rate. Figure 1 is a composite presentation of **all** forecasted dry bulk tonnage to the year 2000. This analysis assumes steadily rising limestone and coal volumes through the late 1990s and a stabilized demand for iron ore through the year 2000. It is apparent that a vessel capacity shortfall could occur by the year 2000.

As shippers scramble to fulfill transportation contracts, better use will be made of available capacity throughout the shipping season. This means more bulk movement both earlier and later in the season. This is the time when, according to some environmentalists, super carrier traffic through iced-over straits and narrows most damages fragile ecosystems. It seems that industry may have erred on the side of caution, opting to have too little capacity rather than too much:

Table 5. U.S.-Flag Fleet dry bulk shipments (net tons)

YEAR	Iron Ore	Coal (western)	Coal (eastern)	Limestone Gypsum	Salt	Sand	Grain	TOTAL Shipments Dry Bulk*
1985	48,531,610	6,990,885	12,312,165	19,646,881	1,434,039	475,455	936,231	90,327,266
1986	43,494,001	8,180,871	12,293,223	19,068,324	1,008,686	537,794	885,036	85,467,935
1987	53,959,899	11,157,326	8,633,635	23,884,125	979,760	571,612	851.092	100,037,449
1988	60,658,012	9,883,138	8,389,826	26,385,150	1,024,126	611,794	785,703	107,737,749
1989	57,098,444	11,467,917	7,973,499	25,108,202	1,144,209	477,430	1,385,798	104,655,499
1990	59,585,338	11,874,789	8,017,376	23,392,822	1,101,683	494,753	998,124	105,464,885
1991	54,888,823	11,405,576	7,218,037	22,233,684	409,507	393,437	1,025,581	97,574,645
1992	56,613,518	10,791,702	7,984,334	21,951,902	623,786	350,855	1,084,055	99,400,152
1993	57,608,273	11,238,423	8,310,488	22,234,518	750,170	436,609	901.543	101,480,024
1994	58,591,775	13,022,395	10,144,608	24,538,768	859,819	426,529	1,098,472	108,682,366
1995	59,272,759	12,803,031	8,484,978	25,824,112	649,526	228.721	1,105,268	108,368,395
1996	60,577,643	12,625,034	8,500,000	26,000,000	750,000	400,000	1,000,000	109,852,677
1997	60,600,000	13,700,000	8,600,000	26,500,000	750,000	400,000	1,000,000	111,550,000
1998	62,200,000	14,000,000	8,200,000	26,000,000	750,000	400,000	1,000,000	112,550,000
1999	57,600,000	14,500,000	8,000,000	25,500,000	750,000	400,000	1,000,000	107,750,000
2000	63,100,000	15,250,000	8,500,000	27,000,000	750,000	400,000	1,000,000	116,000,000

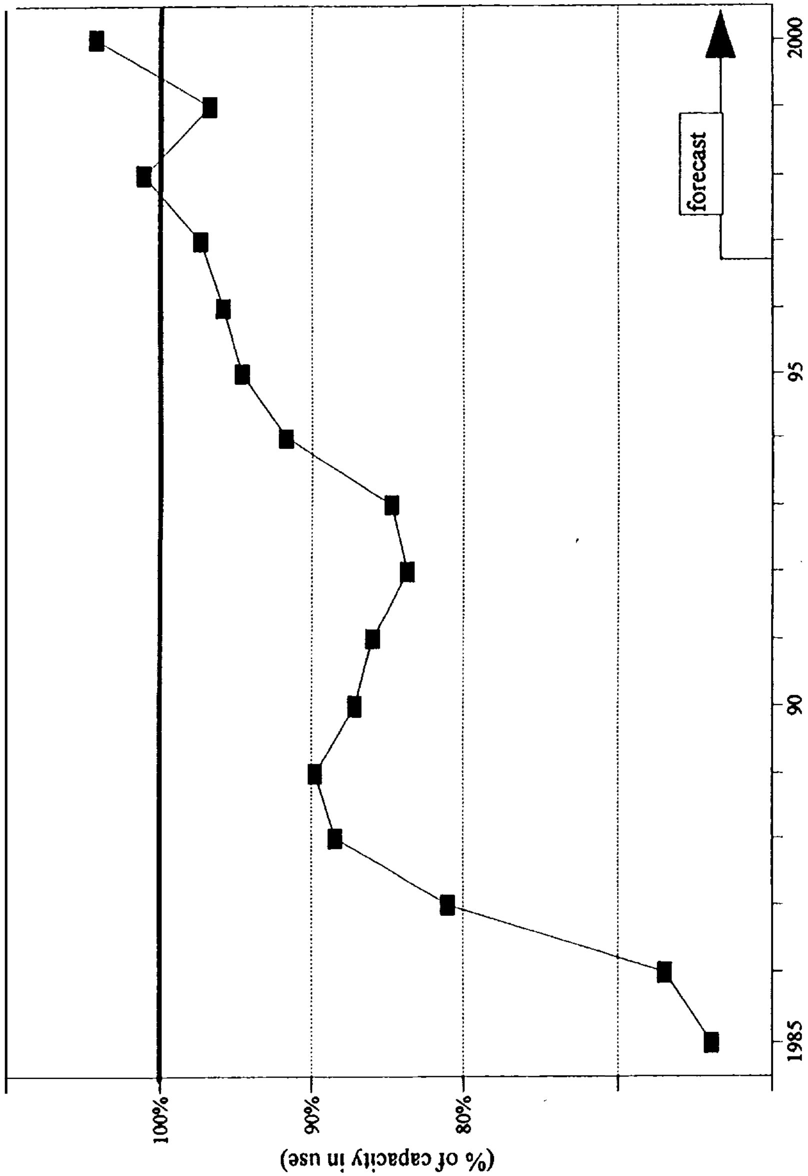
* **Note:** Total **does not include** "Cement & Potash" or "**Liquid** Bulk."

Table 6. U.S.-Flag Fleet capacity used on the Great Lakes (net tons)

YEAR	TOTAL Shipments Dry Bulk*	Number Dry Bulk* Vessels	Carrying Capacity of Fleet	Average Capacity per Vessel	Season Length Poe-days	Est. Ave. trip length (days)	Trips per Season	Season Carrying Capacity	Season Capacity use (%)
1985	90,327,266	84	2,570,102	30,596	275	5.0	55.0	141,355,610	63.9%
1986	85,467,935	74	2,303,734	31,132	277	5.0	55.4	127,626,864	67.0%
1987	100,037,449	60	2,058,140	34,302	300	5.0	60.0	123,488,400	81.0%
1988	107,737,749	58	2,016,375	34,765	302	5.0	60.4	121,789,050	88.5%
1989	104,655,499	58	2,016,375	34,765	289	5.0	57.8	116,546,475	89.8%
1990	105,464,885	58	2,016,375	34,765	300	5.0	60.0	120,982,500	87.2%
1991	97,574,645	56	1,990,183	35,539	285	5.0	57.0	113,440,431	86.0%
1992	99,400,152	57	2,013,290	35,321	295	5.0	59.0	118,784,110	83.7%
1993	101,480,024	56	1,995,233	35,629	300	5.0	60.0	119,713,980	84.8%
1994	108,682,366	52	1,929,523	37,106	307	5.0	61.4	118,472,712	91.7%
1995	108,368,395	52	1,928,851	37,093	297	5.0	59.4	114,573,749	94.6%
1996	109,852,677	52	1,929,523	37,106	297	5.0	59.4	114,613,666	95.8%
1997	111,550,000	52	1,929,523	37,106	297	5.0	59.4	114,613,666	97.3%
1998	112,550,000	50	1,874,755	37,495	297	5.0	59.4	111,360,447	101.1%
1999	107,750,000	50	1,874,755	37,495	291	5.0	59.4	111,360,447	96.8%
2000	116,000,000	50	1,874,755	37,495	297	5.0	59.4	111,360,447	104.2%

* Note: Total does not include "Cement & Potash" or "Liquid Bulk."

Figure 1. **Use of U.S.-Flag Fleet Capacity**



ENVIRONMENTAL IMPACTS OF WINTER NAVIGATION

The greatest concern for environmental impacts of extended-season navigation are for disruption of fish spawning grounds, wetlands, and shoreline facilities. The potential of increase in accidents and ship wreckage were also considered. The biggest problem seems to be the ***back-wash*** or ***side-wash*** under ice. Most of the Upper Great Lakes are frozen over for about three months a year. As ships move through ice, they create waves under the ice—back-wash behind the vessel, side-wash on either side. Because these waves are trapped under the ice layer, their force is concentrated and pushed downward, disturbing the lake bed. With extended-season navigation, back-wash and side-wash can disrupt the spring fish-spawning period.

Two organizations have been particularly vigilant regarding the environmental impacts of the potential of winter navigation—the Michigan Department of Natural Resources (MDNR) and the U.S. Army Corps of Engineers (the Corps). The *Corps* is responsible for ice breaking on the Great Lakes and maintaining the Soo Locks.

In the 1970 Rivers and Harbors Act, the U.S. Congress authorized a 10-year demonstration project to determine feasibility of operating the locks year-round. Congress named the Corps as responsible lead agency in the project. In July 1977, the Corps issued a Final Environmental Impact Statement proposing continued year-round operation in order to meet the needs of commerce. Under pressure from environmentalists, Congress did not approve these recommendations. But the extensive information contained in the EIS resulted in Draft **EIS** Supplement I in October **1979** that reflected a compromise between environmental and commercial interests with a proposed fixed closing date of January 8, plus or minus 1 week.

When the 10-year demonstration period was over, however, the Corps agreed that sufficient information did not exist to rule out cumulative adverse impacts associated with such a fixed closing. For this reason additional extensive environmental and monitoring studies were undertaken, consistent with the NEPA provision that "unquantifiable environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations." **A** formula of freezing degree-days was applied during this time to determine if locks would close before January **8.** The purpose of such a formula was to take into account environmental as well as commercial criteria.

After an expenditure by the Corps of nearly ***$6*** million for impact studies, Draft Environmental Impact Statement Supplement II was issued in March 1988. This draft **EIS** further described the environmental impacts of season extension and proposed a closing date for the locks of January **31**, plus or minus two weeks, so as to meet the reasonable demands of commercial shipping. Otherwise commerce and industry dependent upon navigation would have to resort, during winter, to more expensive alternatives, such as stockpiling. Annual dates of lock operation were to be determined based primarily on the reasonable demands of commerce but also with consideration being given to ice, weather, and environmental conditions.

Draft EIS Supplement II indicated that adverse environmental effects would indeed occur in the St. Mary's River area during the proposed period of extension, but the impact was deemed to be of only minor consequence. "No significant adverse effects on fish and wildlife resources were observed although there were five years of year-round navigation, and nine years of navigation to the end of January (1978).... There is a wealth of ecosystem information available for this project,.. few environmental impact studies have such a wide base of information" **(U.S.** Army Corps of Engineers 1988).

Various government agencies and environmental groups differ sharply with this conclusion and the controversy continues until the present time. "My staff and our expert witnesses, many of whom conducted the environmental studies for the *Corps,* have concluded that there are significant gaps in the data collected" (MDNR 1993). The concerns include "possibility of vessel-induced sedimentation, resuspension of flows, oil and hazardous substance spills, increased drift of seston and benthos [organisms living on the lake bottom], change in fish natural physical shelters, fish and wildlife disturbance, wetlands vegetation destruction or removal, and the alteration of fish breeding and migration behavior" **(U.S.** Army Corps of Engineers 1988). Because the majority of these environmental impacts would occur in Michigan, the primary agencies with which the Corps had to coordinate were the **U.S.** Fish and Wildlife Service and the Michigan Department of Natural Resources (MDNR).

Many of the environmental impact studies of late-season navigation were conducted during the 1980s (see **U.S.** Army Corps of Engineers 1988, 1989; Duffy et al. 1987; and Niimi 1982). In the Corps' opinion, the studies proved navigation was not only safe until mid-January, but could even allow for a closing date of January 31, plus or minus two weeks. This option was declined by the shipping industry in favor of a fixed closing date of January **15.** The lock-closing date was officially set at January 15 during the 1992 navigation season.

In the 1990s, the Corps initiated studies of pre-April 1 navigation in order to determine if a fixed opening date was environmentally feasible. After analyzing the data, the Corps proposed a fixed opening date of March 21 in February 1993 (**U.S.** Army Corps of Engineers 1993.)

MDNR viewed the Corps' environmental studies as inconclusive at best. As a result, the agency more than once considered taking legal action to stop an early opening or late closing of the locks. In 1993, a 1,000-footer left Duluth/Superior not knowing if the Soo Locks would open on March 21 as announced by the Corps. Even as the vessel's lines were cast off, a meeting was being held in Lansing to determine if the state would seek a court injunction to stop the locks from opening. Although an injunction was not sought, negotiation between the Corps, MDNR, **U.S.** Coast Guard, and **U.S.** Fish and Wildlife Service to find a mutually agreeable solution began shortly thereafter. All sides bargained in good faith and an acceptable compromise was found (Shafer 1994.) MDNR agreed to accept a fixed navigation season of March ***25*** to January **15 provided** there were some final environmental studies of pre-April 1 transits through the St. Mary's River. And vessel operators voluntarily agreed to reduce vessel speed in a portion of the St. Mary's River by 2 mph during periods of ice cover.

This compromise has become the current policy.

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