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A System Dynamics Approach to Intermodalism at the Port of Lewiston

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EXECUTIVE SUMMARY

Intermodalism refers to interconnections among modes of transportation, e.g., road, rail, water, and air. Effective intermodal planning must cross boundaries between the public and private sectors as well as transportation modes. The development of an effective and efficient intermodal transportation system requires the identification of barriers to intermodal transportation and the investigation of the impact of proposed changes in infrastructure development, policies, regulations, and planning. A systems approach is necessary to adequately represent the interaction between the sometimes incompatible concerns of all modes and stakeholders. A systems dynamics model of intermodalism at the Port of Lewiston has been developed to highlight leverage points, hidden assumptions, second order effects resulting from feedback loops and system drivers.

A series of casual loop diagrams or models have been developed. The initial model is a diagram displaying the factors important to the development of an intermodal facility. This is intended to act as an introduction to intermodal transportation. Several casual loop diagrams were developed specifically to model intermodalism at the Port of Lewiston. The first Lewiston causal loop model is a high level overview to emphasize the most important factors affecting Lewiston. The following submodels are more detailed models of cost, facility volume flow, economic impacts, environmental issues, and information systems.

The major limiting factor for intermodal transportation through Lewiston is geographic location. Almost all volume flow through the Port of Lewiston is outbound. A consequence of this unbalanced flow is the problem of container availability. The lack of access to empty shipping containers has a significant impact on shipping costs and reduces the international competitiveness of exports through Lewiston. Additionally, the proposed salmon recovery actions such as drawdowns would have significant impact at Lewiston. These are not only direct impacts, e.g., the increased cost of shipment by truck or rail can decrease the competitiveness of products shipped through Lewiston, but the uncertainty over what actions will be taken when, decreases the perception of the Port of Lewiston as a viable option for potential shippers.

A variety of issues common across all intermodal transportation were uncovered in the course of the Lewiston study. These issues include the access and management of data, e.g., ensuring the right data gets to the right people at the right time to enable seamless and efficient intermodal transportation. Tracking container status and making the data available

when needed is perhaps the highest priority for intermodal transportation. Many shippers feel the ability to track shipments is an important component of transportation. The need to track shipments will become more important as JIT (just in time) inventory practices become more widespread.

The first requirement is the ability to collect the right data. The technology currently exists to identify specific containers. Smart cars, electronic tags, or bar codes could be used to automatically update databases of container status whenever the status changes, i.e., moved within an intermodal facility or shipped from the facility. Even if the appropriate data is collected, it also necessary to ensure the data is available to users of the data. The efficient on-demand determination of container status will require more than electronic data interchange (EDI) .

A potential approach for providing a seamless container tracking system is a system that can access data as needed from individual databases. A single request for container status may need to "track" a container through multiple databases to learn the current status. Each individual company would only keep data needed for their own operations but would be required to make the data accessible for outside access. A distributed database would act as type of "EDI on demand" where the information is pulled rather than pushed. A technical solution to this problem can be developed but addressing business issues such as demonstrating benefits to participating companies, ensuring data security, and maintaining trading partner agreements is likely to be the major hurdle to the development of a distributed container tracking database.

Monitoring hazardous cargo is an another area of increasing concern. In addition to tracking container location, there is the need to be able to inform emergency response teams of the contents of the containers and any special requirements for handling incidents during transport. The majority of imports use intermodal transportation. Nonintrusive cargo inspection to identify contraband or hazardous materials as well as enhance revenue collection from undeclared imports is a recognized need. The problem of overweight containers also has been recognized. There have been estimates that up to 30 percent of containers involved in intermodal transportation in the United States are overweight. There is a need for an efficient capability to identify overweight containers and notify shippers and enforcement agencies in a timely manner.

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1 INTRODUCTION

1.1 Background

The State of Idaho recognizes intermodal transportation as an area of unclear definition and significant need. Intermodalism refers to interconnections among modes of transportation and as such requires coordinated transportation policies and decision making. Historically government has addressed transportation in a linear or stove pipe approach. Effective intermodal planning must cross boundaries between the public and private sectors as well as transportation modes. There is a requirement to identify the barriers to intermodal transportation and both identify potential changes and investigate the impact of the proposed changes in infrastructure development, policies, regulations, and planning to ensure an effective and efficient transportation system. The goal is the development of an effective and efficient transportation system for the movement of goods and people where each transportation mode is used for what it does best.

It is necessary to include all significant influences and interactions involved in intermodal transportation. However, it may not be possible to consider all intermodal issues. Transportation covers the movement of people and goods by land, sea, and air. Initially the model will look at surface freight intermodalism in general with emphasis upon issues specific to inland ports and Lewiston in particular. A certain generality will be included to enable the application of the model and its conclusions in a variety of situations and ensure important issues are not excluded.

1.2 Document Overview

The purpose of this document is to present the results of the system dynamics model work. Section two briefly discusses the stakeholders in intermodalism. Section three describes the systems modeling methodology. Section four presents the systems dynamics models developed. Section five presents conclusions reached as a result of the modeling effort. The final section covers the summary and conclusions from the modeling effort. The definition of model elements is included in Appendix A.

2 STAKEHOLDERS AND DECISION SUPPORT CRITERIA

2.1 Stakeholders

The stakeholders in an efficient intermodal transportation system include: shippers, local, state, and Federal governments, transportation providers, environmentalists, intermodal facility providers, and eventually all citizens of the United States.

Shippers require a cost effective way to move goods to their customers. Governments are concerned in a variety of ways including economic development, regulation, international competitiveness and the interaction between these sometimes conflicting goals. Transportation policies have direct impact on the profitability of shippers, transportation providers and facility owners. The interaction between the interests of these stakeholders must be addressed and aligned whenever possible for an effective transportation strategy.

2.2 Decision Support Criteria

It is necessary to determine what criteria each of the stakeholders use for judging the impact of proposed changes in transportation policies and investments. A criteria list is included in Table 1.

Shippers	Minimize costs and maximize the ability to ship their goods to market in a cost-effective, timely manner
Government	Minimize costs to society including environmental, health and safety while maximizing economic development and productivity
Transportation providers and facility owners	Increase business and maximize profitability
Environmentalists	Minimize adverse impacts on the environment

Table 1. Stakeholder Decision Support Criteria

3 METHODOLOGY

A systems approach is necessary to adequately represent the interaction between the sometimes incompatible concerns of all stakeholders. A systems model has been developed to highlight leverage points, hidden assumptions, second order effects resulting from feedback loops, and system drivers. The model is a set of causal loop diagrams which maps a continuum of cause and effect.

3.1 Model Notation

System drivers are the influences that impact how a system behaves, both now and in the future. The analysis of a system and it's behavior requires a clear understanding of the system and the system drivers to determine the relationship between proposed changes and the response of the system to these changes. An example of the methodology to be used in system dynamics modeling is shown in Figure 1.

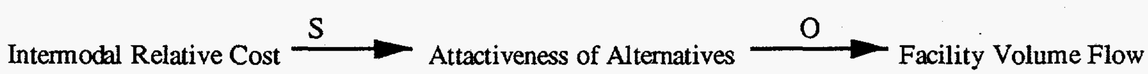

Figure 1. Model Notation

An arrow is used to indicate the relationship between influences within a system. For example in Figure 1, the relative cost of intermodal transportation influences the attractiveness of alternative transportation. The "S" indicates these factors tend to move in the same direction, that is, when the cost of intermodal shipping increases, the attractiveness of alternative shipping methods also increases. A "O" on the arrow relating two factors indicate they tend to move in opposite directions, e.g., if the attractiveness of alternative shipping methods increases, the volume of freight through an intermodal facility will decrease.

3.2 Feedback Loops

Feedback loops can be identified from causal loop diagrams which represent dynamic drivers and influences feeding back upon themselves. Loops are identified as balancing loops or as reinforcing loops. Figure 2 is an example of a balancing loop. The increased volume of goods flowing through the facility will lead to increased river traffic. This can, in turn, lead to demand for increased environmental legislation which increases uncertainty for shippers and thus raises the attractiveness of other shipping modes relative to the intermodal facility. As a result, the volume of goods flowing through the port is limited or balanced at a certain level.

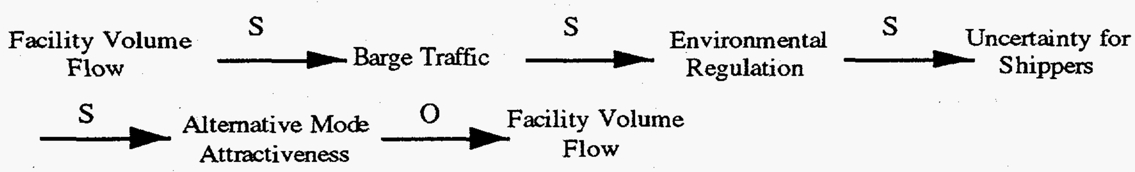

Figure 2. Balancing Loop

Reinforcing loops can be considered vicious (or virtuous) circles. Figure 3 is an example of a reinforcing loop.

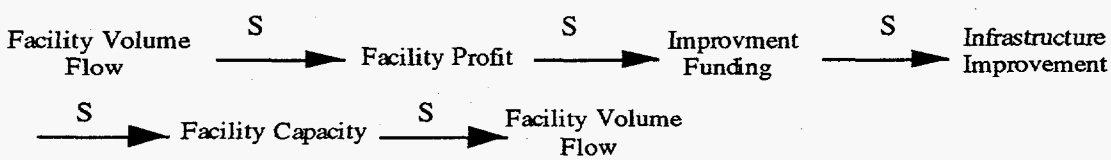

Figure 3. Reinforcing Loop

When the volume of freight through a facility increases, the capital available to invest in further infrastructure improvements becomes available. The improvement in infrastructure increases facility capacity enabling increased volume flow through the facility. This can continue until an external constraint, for example, river or highway infrastructure, or balancing loop stops the positive feedback.

Identification of loops serves two main purposes. The first enables the user to understand system behavior and identify leverage points. Leverage points are those areas where systematic change can most easily be affected. The analysis of feedback loops can also reveal system behaviors that are beyond one's control and where actions to change the system would be unproductive. Additionally unintended, possibly adverse, side effects of proposed changes can also be identified. The second supports model validation, that is, do the loops represent the true behavior of the system.

4 Causal Loop Diagrams

A set of casual loop diagrams or models have been developed. The first is a diagram displaying the factors important to the development of an intermodal facility. This is intended to act as an introduction to intermodal transportation. The remaining causal loop diagrams specifically model intermodalism at the Port of Lewiston.

The first Lewiston causal loop model is a high level overview to emphasize the most important factors affecting Lewiston. The following submodels are more detailed models of cost, facility volume flow, economic impacts, environmental issues, and information systems. Potential changes to the system will be discussed in the final section as these changes may have impacts on multiple submodels. In order to make this report more accessible, the definition of each element used in a causal loop model is contained in Appendix A rather than the body of the report.

4.1 Intermodal Facility Feasibility

Figure 4 displays the factors of importance in determining the feasibility of an intermodal facility. Note: although the arrows in this diagram represent influences, this is not a classic system dynamics model as there are no feedback loops inherent in this process. Nevertheless, this diagram represents the important features that must be considered in any study of intermodalism.

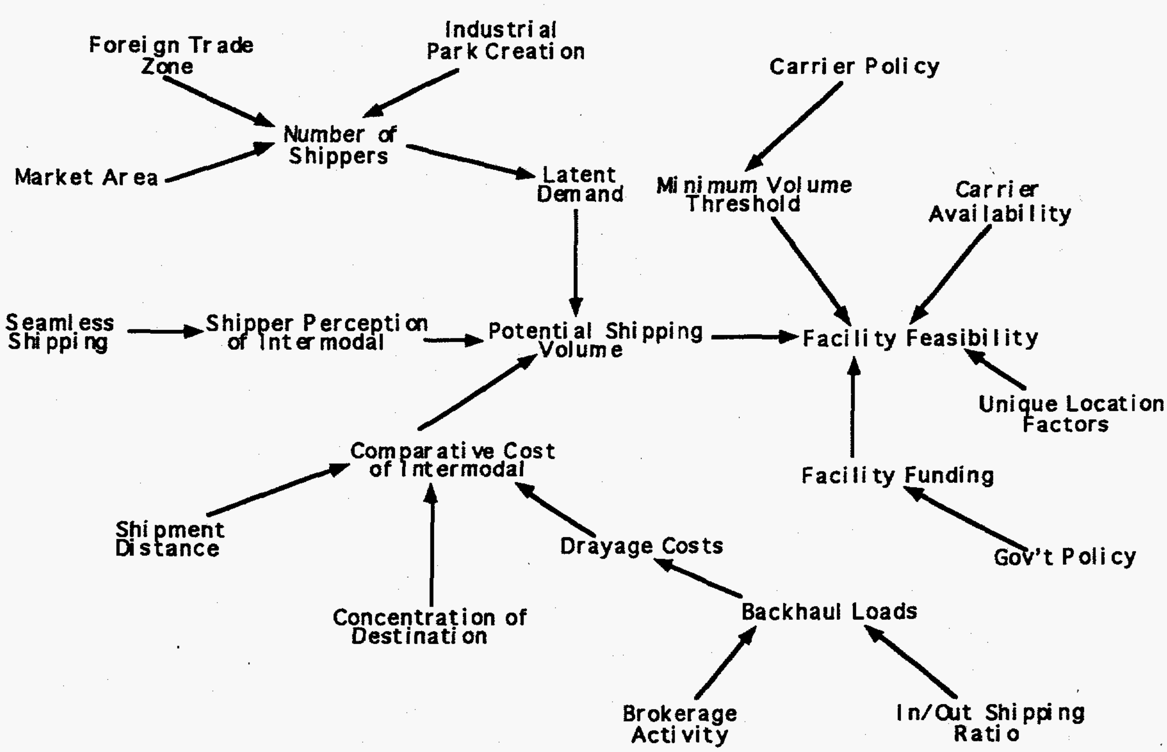

Figure 4. Intermodal Facility Feasibility Diagram

There are two factors in this diagram that are particular relevance in small and medium size cities and rural areas. The first is the potential volume of shipping. Class I railroads operate intermodal facilities as profit centers or have sold their intermodal facilities to train operators who contract for movement and require a minimum volume, usually sufficient for multiple intermodal trains per week. Although commodities from rural areas may meet these volume demands for short periods of time, e.g., harvest, volume requirements are generally a significant barrier to intermodal facilities in small cities and rural areas. The development of industrial parks and/or foreign trade zones are approaches to increasing the volume of shipping for a intermodal facility. The volume concerns can sometimes be addressed by the development of satellite facilities that act as a collection point for transshipment to other intermodal facilities.

The second factor of particular reference to rural areas is the ratio of shipments in and out of the intermodal facility. Rural areas, in general, ship commodities out without significant inbound flow. This can significantly impact the drayage costs due to empty backhauls. This will reduce the potential hinterland of the intermodal facility and thus reducing the potential flow of freight through the facility. If outbound container loads exceed inbound loads, then empty containers must be moved to the facility which raises costs that must be paid by the shippers.

The feasibility of Lewiston as an intermodal facility is driven by its unique location as the first, or farthest upriver, port on the Snake River. This significantly increases its potential market area. In addition, the majority of freight shipped through Lewiston is relatively high volume, low value commodities, e.g., agricultural and forest products which are most appropriate for water transportation. Also, much of the freight shipped through Lewiston is destined for export to the Far East through Portland. e.g., the shipment distance is long and the concentration of final destination is high.

4.2 High Level Lewiston Model

Figure 5 is a high level causal loop model of the Port of Lewiston. This model does not contain detailed views. Particular aspects, including cost, volume, environmental, economic, and information systems will be covered in more detailed models in Sections 4.3 - 4.6.

The major feedback loop in the high level model is reinforcing. A decrease in shipping costs tends to increase export competitiveness in the major industries of forest products and agriculture. Export volume through Lewiston will increase which should have a positive impact on the transportation infrastructure which will, in turn, reduce the transport costs of shipments through Lewiston. An additional theoretical feedback loop results from an increase in the road/rail infrastructure increasing the demographic radius of Lewiston. However, any realistic increase in demographic radius is not sufficient to significantly increase volume flow into the Port of Lewiston.

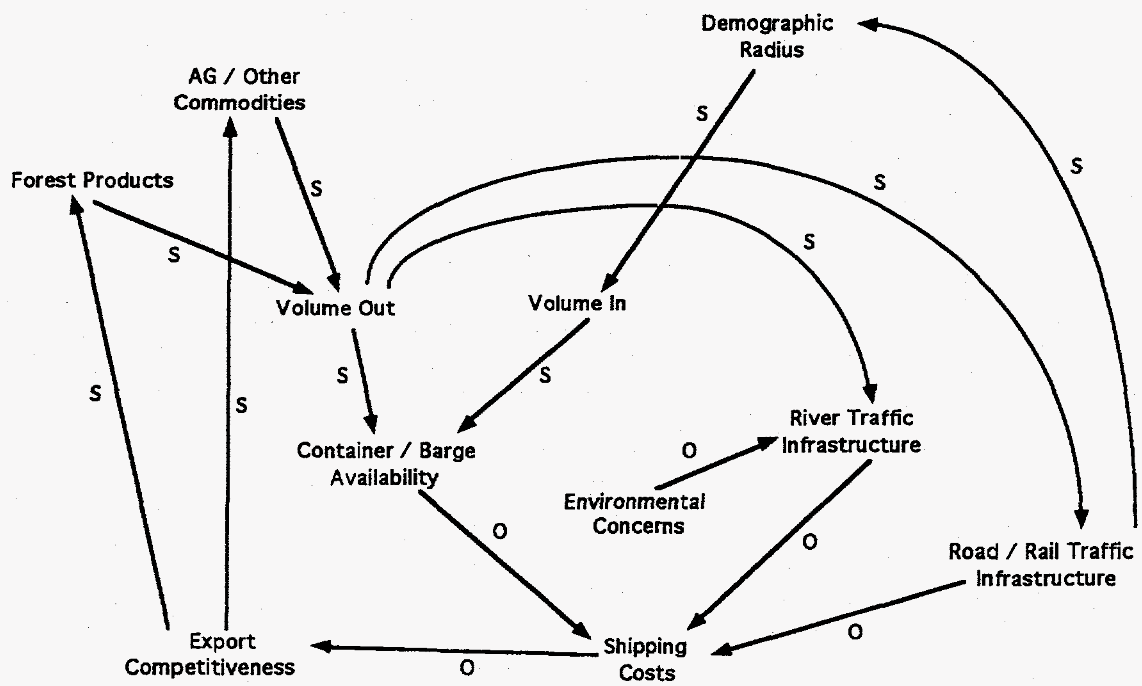

Figure 5. High Lewiston Level Model

The limiting major factor for intermodal transportation through Lewiston is geographical location, e.g., demographic radius. Much of the freight volume is outbound for export through Portland particularly to the Pacific Rim. This is true for the Pacific Northwest in general. Approximately nine containers are shipped out of Portland for each container shipped into Portland. A consequence of this unbalanced flow is the problem of availability of containers. The lack of access to empty shipping containers has a significant impact on shipping costs and reduces the international competitiveness of exports through Lewiston. Additionally, Portland is an expensive port and is currently not well suited to handling the largest container ships. Grain exports are less affected since most grain is shipped in bulk. Bulk cargo ships are generally smaller than container vessels and are not as affected by channel depths to Portland.

Although the impact of salmon recovery actions are not explicitly displayed on the top level diagram except as Environmental Concerns, interruption of river shipping due to river drawdowns will have a significant impact. The impact will vary by industry. The impact will be particularly severe on the international competitiveness of the forest products industry, including the mill complex at Lewiston, which has less seasonal shipping requirements than the grain shippers. This can impact the Port of Lewiston as the mill complex is both a major shipper through the port and a source of backhauls from Lewiston. The availability of backhauls affect the cost of drayage of products to Lewiston for shipment through the port. The closure of the north-south railroad gap from Lewiston would provide increased shipping options for the mill complex, especially for domestic sales to the East, as well as potentially increasing the market area of the port.

4.3 Lewiston Cost Model

Figure 6 shows the influences on the costs of shipping through the Port of Lewiston.

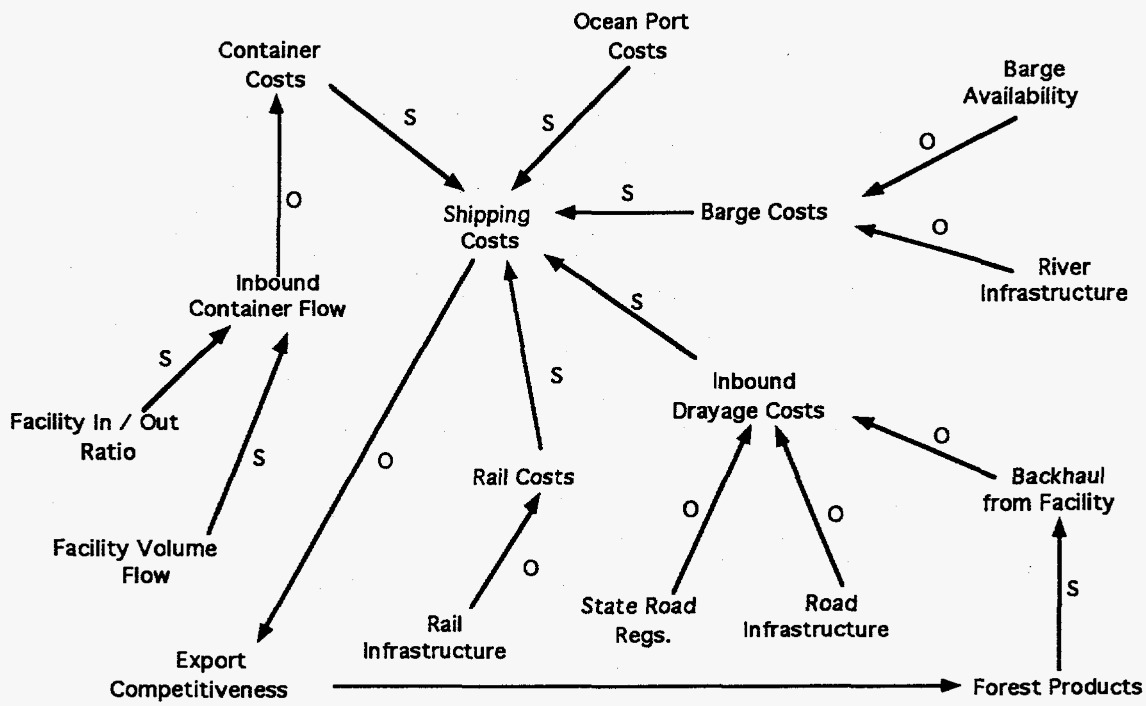

Figure 6. Cost Model

Only one feedback loop is explicitly contained in this diagram. As shipping costs decrease, the competitiveness of exports increases which results in more activity in forest products. This will increase the potential for backhauls for truckers bringing products to Lewiston which will decrease the drayage cost to Lewiston which, in turn, reduces the overall shipping cost. This loop can be limited by ocean port costs, e.g., Portland, container availability, and the potential for barge costs to increase due to changes in the river infrastructure resulting from salmon recovery actions. Although these factors are considered limiting factors, costs can be decreased (and flows increased) by changing the level at which the limitations take effect. Container availability is discussed in more detail in the final section of the report.

4.4 Lewiston Volume Flows

Figure 6 is the causal loop model displaying the driving factors for volume flow through Lewiston.

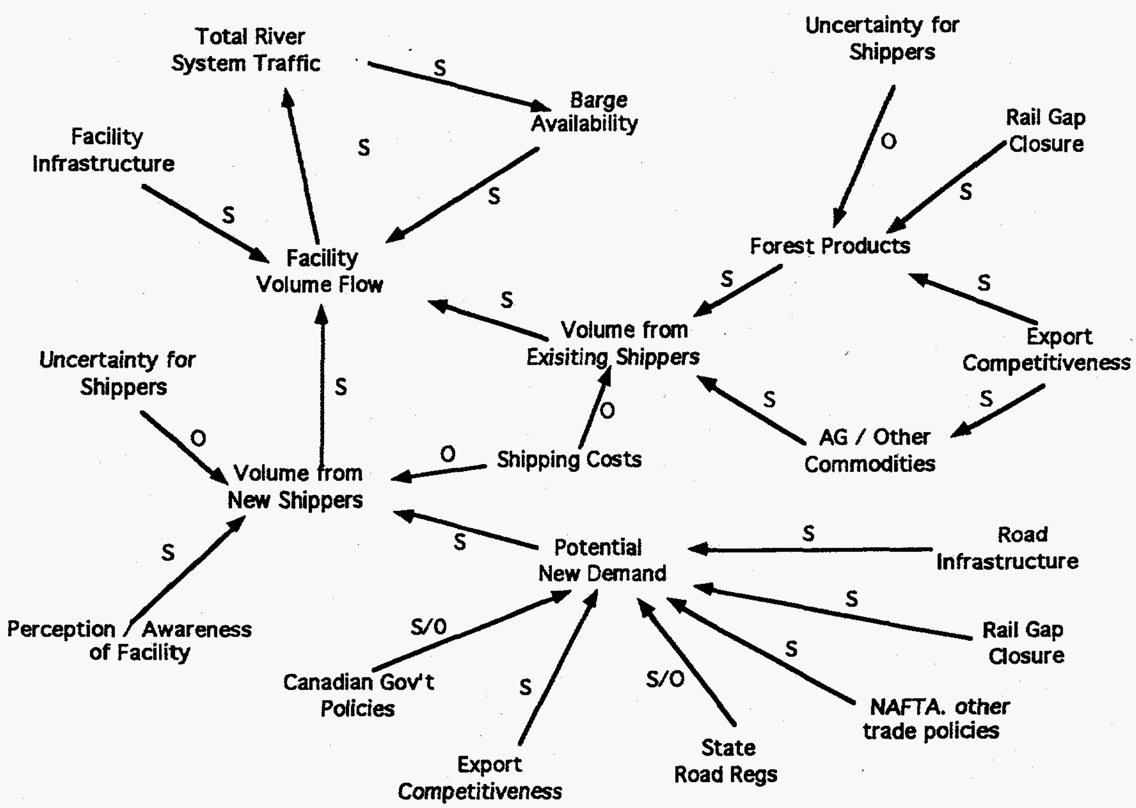

Figure 7. Lewiston Volume Flows

Marketing goals at the Port of Lewiston are to increase volume from the existing market area as well as increasing the market area. Potential salmon recovery actions impact both goals and are discussed in greater detail in the following sections. The salmon recovery actions, particularly drawdowns, will both increase transport costs and introduce an element of uncertainty into the perception of Lewiston as a viable intermodal center. Shipping costs are a major driver though the impact on export competitiveness of products shipped through Lewiston.

The Port of Lewiston is currently attempting to increase its hinterland. Potential new shipments are possible from as far as Southeast Idaho and Calgary and Lethbridge in Canada. Changes in Canadian government policy concerning subsidies for shipment of exports through Vancouver, British Columbia, have made Lewiston a more viable option for Canadian exporters. However, Idaho state road regulations, truck load limits, etc., differ those in from Canada which raise barriers to these exports. This is also true for export of products from other states in the USA. Potential Canadian exports through Lewiston will also be affected by the infrastructure at Seattle/Tacoma as Canadian exports must "cross" the main rail line to Seattle to reach Lewiston.

The improvement in the road and rail infrastructure into Lewiston can also play a role in increasing the competitiveness of Lewiston. This is particularly true for the closure of the rail gap between Lewiston and Moscow. This prevents the shipment of freight directly to the Burlington Northern east-west main line. Currently, all rail shipments from Lewiston to the eastern United States must first be sent to the Tri-Cities in eastern Washington via the Camas Prairie Railroad. A significant secondary impact of the rail gap closure is to increase the transport options for the mill complex at Lewiston which impacts the economic viability of the Lewiston area and also provides the potential for backhauls for other products brought to Lewiston.

4.5 Environmental Influences

The impact of salmon recovery actions, especially drawdowns, are of great concern to shippers through the port of Lewiston. The environmental submodel is shown in Figure 8.

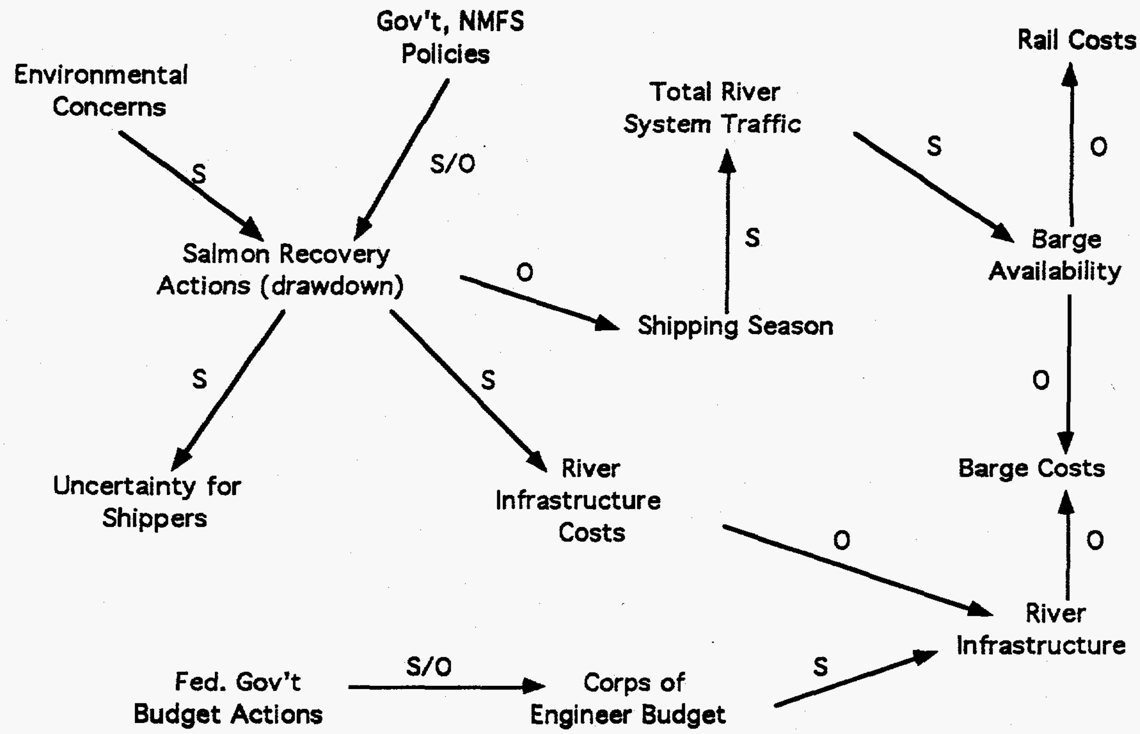

Figure 8. Environmental Impacts

The impact may vary by product, e.g., a drawdown my coincide with low shipping demand for grain, however, costs will be increased for all river transportation users. Costs increase due to increased infrastructure maintenance, a drawdown may increase silting of the channel, and decreased usage of capital investments, tows, barges, and other infrastructure, of the shipping companies and ports. A 30 cents per ton increase, about 6 percent, occurred in mid-1991 in anticipation of a drawdown disruption. Perhaps as important, the current uncertainty impacts the perception of Lewiston as a reliable transportation option. The indirect costs on the regional economy may also be significant. The loss of river transport will increase the transportation cost of products with a resulting loss of international competitiveness. The uncertainty also influences the decision making process concerning the expansion of current or potential future economic activity. The impact of salmon recovery actions will be considered in more detail in Section 5.3

4.6 Regional Economic Impacts

The regional economic impact of the Port of Lewiston is shown in Figure 9 The major regional economic activities are forest products and agriculture. Each has a high percentage of exports. The competitiveness of these products in the international marketplace is strongly dependent upon the transportation infrastructure and the Port of Lewiston. Salmon recovery actions such as drawdowns can have a significant impact on the regional economy by increasing transportation costs. In addition, the current uncertainty as to the year around availability of river transportation impacts the potential for the attraction of new economic activity to the Lewiston area as the availability of river transport would be a major factor, together with low electricity costs, in the decision to locate in the Lewiston area.

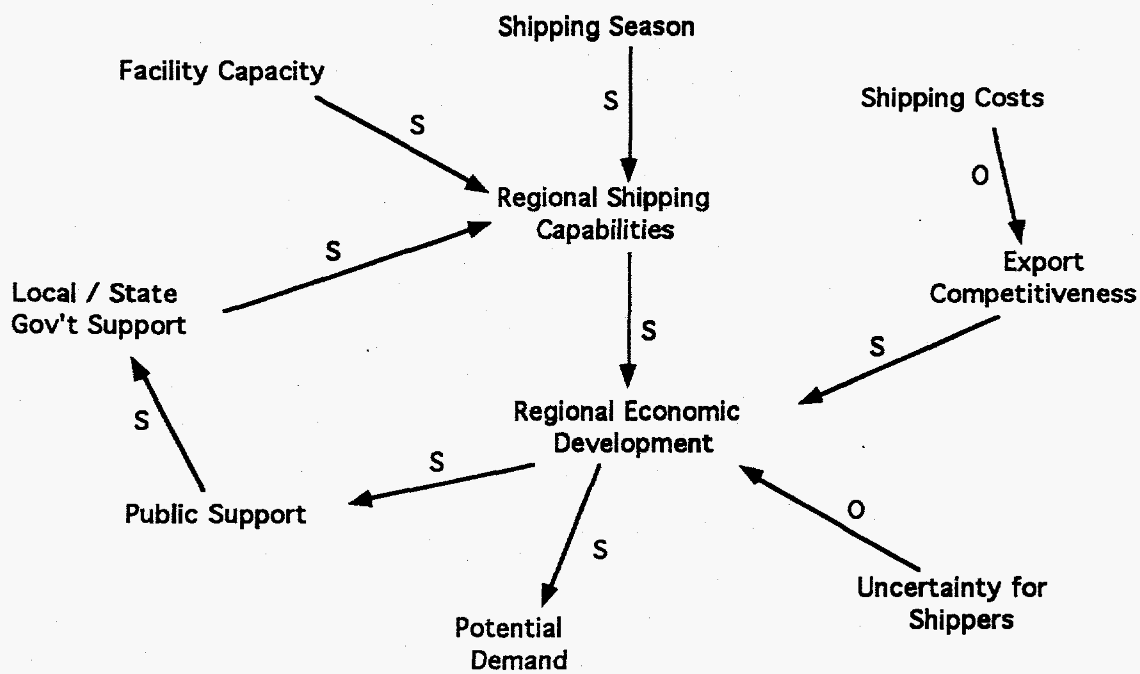

Figure 9. Regional Economic Impact

4.7 Information Systems

The current information environment at the Port of Lewiston and the Columbia Snake River System is pockets of automation. Most of the personnel interviewed expressed support for acquiring additional EDI (electronic data interchange) capability in order to better communicate with trading partners. The impact of information systems in intermodal transportation is shown in Figure 10. There are two aspects that must be considered. The first aspect is what information to collect while the second aspect is to ensure that the right information reaches the right people at the right time.

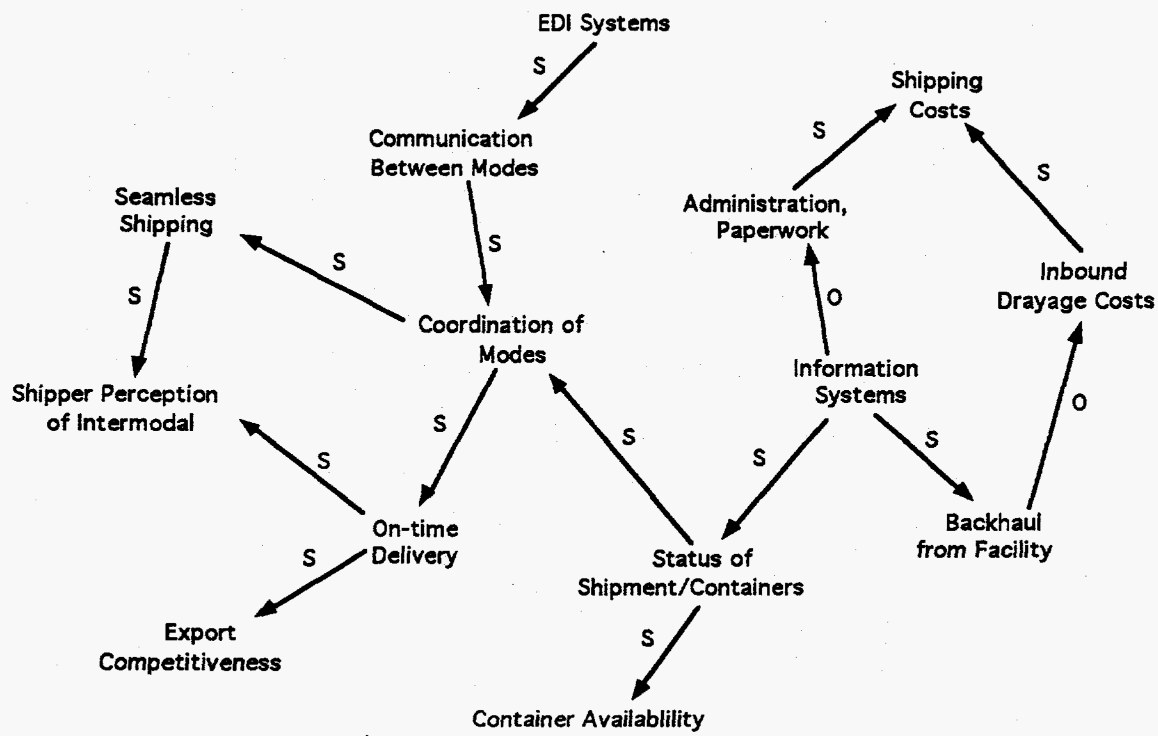

Figure 10. Information Systems

The impact of information systems fall into three major areas. The first is the reduction of shipping costs. This comes about from the reduction of paperwork and administration and the increased efficiency in utilization of assets. For example, knowing the status of containers will better enable containers to be located where needed. In addition, information systems will increase the likelihood of on-time delivery. On-time delivery is more important for manufactured products especially for JIT (just in time) inventory systems. Finally, information systems help to provide seamless shipping, a single point of contact for billing and determination of shipment status to the intermodal shipper. Information systems will be discussed further in Section 5.4

5 Model Results

This section will contain the discussion of potential leverage points in the system. Leverage points are those areas where systematic change can most easily be affected or have the greatest impact on system behavior.

5.1 Container Availability

Container availability was cited several times as an important influence on transport costs from Lewiston. An example was given that containerized forest products can exported to the Far East cheaper from Scandinavia (or Arkansas) than Lewiston due to the availability of containers and the cost of shipping empty containers to Lewiston. Container shortage at Lewiston results from both the imbalance of flow and the fact that container shipping fees are based on the value of the container contents. As Lewiston exports, in general, high volume, relatively low value products, Lewiston is not a high priority for shipping companies to provide empty containers. Additionally, containers are being used for temporary storage due to the earthquake at Kobe which exacerbates the current container shortage.

The best solution to the container problem at Lewiston would be to increase the volume of goods brought into Lewiston by container. The current level is essentially zero. The economic geography of Lewiston makes this approach somewhat impractical. One possibility is the creation of a free trade zone to encourage imports with the potential re-export to Canada. However, this could also be undertaken by other Columbia/Snake river ports that have a better transportation infrastructure than Lewiston. It was mentioned by one interviewee that Walmart was building a distribution center at a river port which is at the intersection of two interstates.

Another possibility is for Lewiston to become the staging area for containers for an increased market area. For example, an executive of an intermodal facility at Lewiston stated that he could compete with containers shipped from Eastern Idaho by rail through Nampa if the products were shipped to Lewiston and loaded into containers at Lewiston thus avoiding the shipment of containers to the point of shipment origin. However, the trust of the individual shippers that the containers will be correctly loaded must be ensured. Cheap and efficient electronic verification of proper container loading may be one area to consider.

5.2 Drayage Costs

Drayage costs are a large percentage of the overall intermodal transportation cost. It has been estimated that drayage costs are 40% of total door to door rates in 1000 mile road/rail intermodal shipment. These costs can be reduced by backhaul shipments, e.g., the carrier bringing freight to the intermodal facility does not return empty. At Lewiston, the lack of inbound freight to the port limits backhaul shipments. However, the mill complex at Lewiston, which produces paper products, does provide backhaul shipments to trucks bringing freight to the Port of Lewiston. The mill complex has an impact on the Port of Lewiston greater than its significant percentage of outbound container and bulk shipments of forest products for export.

The backhaul problem is common to many intermodal facilities. These have been mitigated in several cases by the intermodal facility acting as a freight broker matching loads with shippers. This may not be a viable option for the Port of Lewiston due to the minimal amount of inbound freight into the Port and the general level of economic activity in the immediate Lewiston area. Additionally, the information management systems necessary to perform this activity do not currently exist at the port. The port does not participate in scheduling shipments.

5.3 Salmon Recovery Actions

Salmon recovery actions, such as drawdowns, will have a significant impact on the Port of Lewiston. These actions will impact other ports on the Columbia / Snake river system but the impact on Lewiston will be greatest because it is at the head of the navigable portion of the river system. The drawdowns will, in essence, make the port unavailable for river traffic for certain periods of the year, possibly 8 - 12 weeks. The lower Snake river ports are presently shut down approximately 2 weeks each year for infrastructure, e.g., locks, etc., maintenance. Additionally, the costs of maintaining the river infrastructure may increase as the drawdowns can increase sediment deposits which will require more dredging.

The magnitude of the impact may vary by product, for example, the peak demand for grain shipments occurs later in the year than the potential drawdowns, but these actions will adversely impact transport costs for all export products in the Lewiston hinterland. The drawdowns will have a direct impact on the forest products industry. For example, the impact on the mill complex at Lewiston is estimated to be several millions of dollars per year in transport costs. There are also additional potential secondary impacts. The availability of containers is already a problem at Lewiston. River inbound shipments of empty containers is relatively inexpensive. If during drawdown periods, empty containers must be shipped in and out by rail, transport costs will increase by more than the higher cost of rail versus river shipments to Portland. Additionally, the increased transport costs during drawdown periods may influence economic decisions to maintain or expand existing economic activities. The reduction in activities of existing business such as the mill complex will impact other potential shippers through Lewiston even in non-drawdown periods by reducing the potential for backhauls of freight out of Lewiston.

5.4 Information Systems

Perhaps the most important aspect of improved information systems is the ability to improve reliability of delivery. For many shippers, reliability of delivery is as important as delivery time or even, to a certain extent, cost. Increased knowledge of shipment location, "tracing the load", was identified by several truck-only shippers as an important service characteristic to them, in a study by Casavant, et. al. 1991. The importance of knowledge of shipment status, coordination between modes, and on-time delivery will only increase as JIT (just in time) inventory management becomes more common in an increasingly competitive world economy.

The need for a container tracking system on the Columbia-Snake is well known. The Port of Portland has been active in the development of a container tracking system. This system consists of a container database which contains details such as container number, status, condition, size, owner, port of dispatch, port of loading, etc. The system also includes the capacity to send and receive an EDI document (322, Terminal Operations Activity (Ocean)) to trading partners concerning the status of containers. All messages are sent via a value added network (VAN) which requires trading partners to subscribe to the same VAN. Received EDI 322 documents will automatically update the container database. There is also a capability to import and export container information with internal company databases using a flat-file interface. This system is currently under test and the Port of Portland would like it to become the standard for all ports and other companies involved in intermodal transport on the Columbia-Snake River system.

Additionally, information systems can be used for brokerage functions, i.e., to provide backhauls for trucks bringing freight to an intermodal facility. For example, the North Carolina State Ports Authority provides a brokerage function at satellite facilities at Charlotte. By means of this brokerage function, the Authority charges $0.92 per mile to Wilmington where trucking firms would normally charge $1.70. This effectively increases the market area of the Port of Wilmington. This opportunity is less viable at Lewiston due to the imbalance of flow through the port, however, the mill complex at Lewiston and other local business may be potential sources of backhaul freight.

6 SUMMARY AND CONCLUSIONS

The systems dynamics models developed reveal important factors driving intermodalism both in general and specifically at Lewiston. The summary and conclusions will consist of two sections, those pertaining to specifically to Lewiston and those pertaining to both Lewiston and intermodalism in general.

6.1 Port of Lewiston

Many issues at the Port of Lewiston result mainly from its geographic location. These issues can be summarized as access infrastructure, environmental and salmon, and volume flow imbalance.

Access Infrastructure: The need for the closure of the north-south rail gap, Moscow to Arrow line, was an important access infrastructure issue. It was noted that when barges started moving on the river, it pulled a lot of traffic off the line. Reopening the line could help mitigate the impacts of river traffic shutdown due to salmon recovery actions. The ITD has expressed its willingness to participate in this project through planning and administering funds through the federal Local Rail Freight Assistance (LFRA) Program. However, LFRA funds require a guarantee of traffic of a minimum of 40 cars/mile per year for qualification of LFRA funds for abandoned lines. The uncertainty of salmon recovery actions also creates uncertainty in the potential demand for freight on the Moscow-Arrow line. An economic study of the economic impact of the reopening of the Moscow-Arrow line and the determination of projected traffic on the line, both with and without river drawdowns is a need in this area.

Environment and Salmon Recovery: Salmon recovery actions and potential drawdowns are legal and political decisions. The major need is the reduction in uncertainty so that shippers and transportation providers can determine optimal mitigation strategies if needed. Additionally, the uncertainty detracts from the capability of the Port of Lewiston to market itself as a provider of reliable intermodal transportation services.

Volume Flow Imbalance: The volume flow imbalance results from the geography and demographics of the Lewiston hinterland. Increasing input flow to an appreciable extent is at best a difficult proposition. This is exacerbated by the uncertainty resulting from potential salmon recovery actions as the availability of river transport is a major attraction to the Lewiston area. Volume flow imbalance is not, however, limited to the Port of Lewiston. Throughout the Pacific Northwest, the volume flow of exports exceeds the flow of imports. In the Northeastern United States, the flow imbalance is reversed with import flow often exceeding export flow.

A potential next step in system dynamics modeling is the creation of a simulation from the causal loop models. However, the relationships between model elements are qualitative rather than quantitative in nature. The correlation may be known to be positive or negative, e.g., increasing the export competitiveness of forest products produced at the mill complex at Lewiston will increase the volume of forest products shipped through the Port of Lewiston, but quantifying this relationship is not easy. This makes the process of computerizing the systems dynamics models which requires the quantification of the relationships between model variables, a difficult process. Converting these models to a simulation is not recommended unless specific questions need to be answered. In this case, the models can be simplified and the number of relationships that need to be quantified can be reduced.

6.2 Intermodal Issues

A variety of additional issues common across all intermodal transportation were uncovered in course of the Lewiston study. These issues involve the access and management of data, e.g., ensuring the right data gets to the right people at the right time to enable seamless and efficient intermodal transportation.

Tracking container status and making the data available when needed is perhaps the highest priority for intermodal transportation. Many shippers feel the ability to track a shipment is an important component of transportation. This issue becomes more complex as the number companies involved in a shipment increases. In a typical shipment through the Port of Lewiston, a shipment may be handled by two drayage companies, three port handling facilities, an ocean shipping line, and a barge company. In addition, advance notice of container arrival would enable more efficient transit of containers through intermodal facilities. At many intermodal terminals this information is not available in a timely manner.

The first requirement is the ability to collect the right data. The technology currently exists to identify specific containers. Smart cards, electronic tags, or bar codes could be used to automatically update databases of container status whenever the status changes, i.e., moved within an intermodal facility or loaded and shipped from a facility. The obstacles to container tagging are not technical but institutional. Container fleet owners and users worldwide need to agree on an international standard but there is currently no global agreement. Proposals have been made to tag railcars which transport containers to help alleviate this problem using automatic equipment identification standards developed in accordance with International Standards Organization DIS 10374.

An additional barrier exists between partners in the intermodal chain, especially export of goods. There are efforts underway to establish an unique export numbering system, as is available for imports (as mandated by U.S. Customs). Export bill of lading numbers used by steamship companies may not be related to the bill of lading systems used by the railroad or barge company.

Even if all appropriate data is collected, it necessary to ensure the data is available to users of the data. Automatic EDI or fax transmissions can be sent when container status changes, i.e., the Portland container handling facility is notified when a container is loaded onto a barge at Lewiston for transfer to Portland. This can increase the efficiency of intermodal transportation but it would not necessarily address the ability of a shipper (or the intended recipient of the shipment) to seamlessly determine the status of a shipment or container en-route. On-time delivery reliability and container tracking will become increasingly important as JIT (just in time) inventory systems become more prevalent.

The efficient on-demand determination of container status will require more than EDI. A centralized database of container status could be developed and maintained by one or more parties in the intermodal chain which is updated using EDI messages whenever container status changes. The logical candidate for a centralized container status database would be the container owner (usually the steamship company for import / exports). However, the advantage to either the database owner in providing a tracking service or the companies in the intermodal chain updating the database as needed is unclear.

One potential alternative for providing a seamless container tracking system is a system that can access data as needed from individual company databases. A single request for container status might require the system to "track" a container through multiple databases to learn the current status. Each individual company need only keep data needed for their own operations but would be required to make the data accessible for outside access. The centralized database would be replaced by a distributed database which would act as type of "EDI on demand" where the information is pulled rather than pushed. A technical solution to this problem can be developed but addressing business issues such as demonstrating benefits to participating companies, ensuring data security, and maintaining trading partner agreements is likely to be the major hurdle to the development of a distributed container tracking database.

A potential alternative which would eliminate the need for storing data and interrogating databases would require an active GPS container location system on the container itself. The shipper could initialize the container location system with data concerning the container contents, destination, and other bill of lading information. Whenever the shipper, intended recipient, or shipment handler requires data concerning container and its location, the container location system could be remotely queried and the current location reported to whomever performed the query. Although such a system is certainly technically feasible, the cost effectiveness of a system would need to be investigated.

A variety of other issues are of importance to improving intermodal transportation. These issues include: monitoring of hazardous goods, overweight containers, and border crossings and nonintrusive cargo inspection.

Monitoring of hazardous goods: This is an issue that is a special case of container tracking. In addition to tracking container location, there is the need to be able to inform emergency response teams of the contents of the containers and any special requirements for handling incidents during transport.

Overweight containers: Road weight limits vary between countries and even from state to state within the United States. There have been estimates that up to 30 percent of containers involved in intermodal transportation in the United States would be overweight if transported by truck. This especially applies to containers of commodity exports from the Pacific Northwest. Technical solutions such as "super chassis" trucks exist but efficient utilization of this equipment depends on efficient exchange of container weights and contents. Availability and exchange of this information, including government agencies and enforcement authorities, is a critical missing factor in enforcement practices.

Border crossings and nonintrusive cargo inspection: The majority of imports and exports, are intermodal in nature. There has been a large increase in international trade resulting from NAFTA and other agreements. To reach the goal of efficient intermodal transport of international trade, the process of crossing international borders must be made more efficient. Currently cargo inspection is a time-consuming and manual process. Additionally, only a small percentage of imports can be inspected. There is a need for a method of quickly and automatically screening cargo containers. Nonintrusive automated cargo inspection will not only detect contraband but enhance revenue collection from undeclared imports and aid in the identification of hazardous products.

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APPENDIX A. MODEL DEFINITIONS

This appendix provides short definitions of all model elements. The definitions are grouped into two tables. The first table lists the model definitions for the intermodal facility feasibility model while the second contains all definitions used in the remainder of the models related to the Port of Lewiston.

Intermodal Facility Feasibility

Backhaul Loads	The volume of freight transported from an intermodal facility by trucks bringing freight to the intermodal facility.
Brokerage Activity	Coordination of drayage movements to minimize empty backhauls from the intermodal facility.
Carrier Availability	The availability of railroads, river transport, etc. required for an intermodal facility.
Carrier Policy	The conditions, including volume of freight, etc. which determine whether a carrier will develop or serve an intermodal facility.
Comparative Cost of Intermodal	The cost of shipping freight through an intermodal facility relative to other shipment options.
Concentration of Destination	The percentage of shipments out from an intermodal facility that have the same final destination.
Drayage Costs	The cost of transporting freight by road to the intermodal facility.
Facility Funding	Funding available for construction and development of the intermodal facility.
Facility Feasibility	A measure of the feasibility of an intermodal feasibility.
Foreign Trade Zone	A site where foreign and domestic merchandise is generally considered to be in international commerce.
Gov't Policy	A measure of the willingness of governments, Federal, state, and local to support the establishment of an intermodal facility.
In / Out Shipping Ratio	Ratio of volume of freight shipped into the

	intermodal facility versus out of the intermodal facility
Industrial Park Creation	The areas of infrastructure designed to attract industry and other economic activity.
Latent Demand	The existing possible demand for using the intermodal facility for shipment, e.g., existing single mode shipments.
Market Area	Geographic area containing shippers (potentially) using the intermodal facility.
Minimum Volume Threshold	The minimum volume of freight shipments need to make an intermodal facility feasible.
Number of Shippers	The number of shippers in the intermodal facility market area.
Potential Shipping Volume	Potential volume of freight that can be shipped through the intermodal facility.
Seamless Shipping	A measure of simplicity of use of intermodal transportation for the shipper.
Shipment Distance	The average length of haul for freight shipped through the intermodal facility.
Shipper Perception of Intermodal	A measure of how shippers look at the quality of shipping through intermodal facilities.
Unique Location Facility	A catch-all for unique geographic considerations for the site of an intermodal facility.

Port of Lewiston Models

Administration, Paperwork	Paperwork and overhead involved in an intermodal shipment.
AG / Other Commodities	A measure of the volume of agricultural and other commodities shipped through the Port of Lewiston.
Backhaul from Facility	The volume of freight transported out of Lewiston by carriers that transported freight into the port for river transport from Lewiston.
Barge Availability	A measure of the availability of barges when needed.

Barge Costs	The cost of shipping freight by barge from Lewiston to Portland or other destinations.
Communication between Modes	A measure of the communications between modes concerning an intermodal shipment
Canadian Gov't Policies	The impact of Canadian government policies on shipment of goods through Lewiston.
Container Availability	A measure of the availability of containers when needed.
Container / Barge Availability	The availability of containers and barges for the shipment of products out of the Port of Lewiston.
Container Costs	The portion of shipment costs due to making containers available for the shipment of freight.
Coordination Between Modes	The ability of the different modes, river, truck, etc. to track shipments.
Corps of Engineer Budget	The budget of the Corps of Engineers available for river infrastructure maintenance and improvement.
Environmental Concerns	The level of public and political concern for salmon recovery.
Demographic Radius	The market radius of the Port of Lewiston.
EDI Systems	A measure of the ability to communicate with trading partners using electronic data interchange (EDI)
Export Competitiveness	The international competitiveness of products shipped through the Port of Lewiston.
Facility Capacity	A measure of the physical capacity for shipment of goods through the Port of Lewiston.
Facility Infrastructure	A measure of the infrastructure available at the Port of Lewiston.
Facility In/Out Ratio	The ratio of volume freight shipped in by river to the volume of freight shipped out by river through the Port of Lewiston.
Facility Volume Flow	The total volume of freight shipped through the Port of Lewiston.
Fed. Gov't Budget Action	Federal government budgetary policies which can impact Corps of Engineers funding.

Forest Products	A measure of the volume of forest products, paper, wood chips, etc. shipped through the Port of Lewiston.
Gov't, NMFS Policies	Federal government and National Marine Fisheries Service policies toward salmon recovery.
Inbound Container Flow	The number of loaded containers shipped into the Port of Lewiston.
Inbound Drayage Cost	A measure of the cost of shipping freight or commodities from the point of origin to Lewiston for barge transport
Information Systems	Computer and other system used to track shipments, billing, etc.
Local / State Gov't Support	A measure of the support for the Port of Lewiston from state and local governments.
NAFTA, Other Trade Policies	A measure of trade policies and their impact on shipment flows through Lewiston.
Ocean Port Costs	The portion of shipment costs from completion of river transport to final destination.
On-time Delivery	The percentage of shipments that are delivered as scheduled.
Perception / Awareness of Facility	The awareness of Lewiston as a potential avenue of shipment of goods.
Potential Demand	The total potential shipment volume from the market area of the Port of Lewiston.
Potential New Demand	A measure of demand for freight shipment through Lewiston that does not currently exist.
Public Support	A measure of public support for the Port of Lewiston.
Rail Costs	The costs of shipping goods to and from Lewiston by rail.
Rail Gap Closure	The closure of the rail gap from Lewiston to Moscow permitting shipment of goods from Lewiston north to the BN main line.
Rail Infrastructure	A measure of the ability to ship goods into and out of Lewiston by rail.
Regional Economic Development	A measure of the economic activity in the Lewiston

	area.
Regional Shipping Capabilities	A measure of the shipping capabilities, road, rail, and river, in the Lewiston area.
River Infrastructure	A measure of the ability to ship goods into and out of Lewiston by river.
River Infrastructure Costs	A measure of the cost required to maintain the river infrastructure into / out of the Port of Lewiston, e.g., dredging, lock maintenance, etc.
River Traffic / Infrastructure	A measure of the total traffic and supporting infrastructure on the Columbia / Snake river system.
Road Infrastructure	A measure of the ability to ship goods into and out of Lewiston by road.
Road / Rail Traffic / Infrastructure	A measure of the ability to ship goods into and out of Lewiston by road or rail.
Salmon Recovery Actions	Actions taken to alleviate the causes of salmon endangerment and ensure survival of the species.
Seamless Shipping	A measure of simplicity of use of intermodal transportation for the shipper.
Shipper Perception of Intermodal	A measure of how shippers look at the quality of shipping through intermodal facilities.
Shipping Costs	A measure of the cost of shipping freight or commodities from its point of origin to final destination.
Shipping Season	The portion of the year when barges can be used into and out of the Port of Lewiston.
State Road Regs.	A measure of the impact of state of Idaho road regulations, load limits, etc. that impact freight shipments through the Port of Lewiston.
Status of Shipment / Containers	The ability to determine the location and status of a container or shipment
Total River System Traffic	Total volume of barge traffic on the Columbia / Snake river system.
Uncertainty for Shippers	A measure of the perception of shippers of the reliability of the Port of Lewiston as a means for the shipment of goods or freight.

Volume from Existing Shippers	The volume of freight shipped through the Port of Lewiston by shippers that already use the port.
Volume from New Shippers	The potential volume of freight that could be shipped through the Port of Lewiston by shippers that do not use the port.
Volume In	Volume of river freight inbound to Lewiston.
Volume Out	Volume of river freight outbound from Lewiston.