Economic Risks of the Morrow Pacific Project:

Livelihood, Habitat and Recreation

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I. Executive Summary

The Morrow Pacific coal barge export project has been presented to the public as a relatively "clean" alternative to exclusively train-based coal export schemes. This briefing demonstrates that far from being a "clean" project, Morrow Pacific would jeopardize vital, valuable economic, cultural and ecological resources throughout Western Oregon, including salmon habitat, recreational, scenic and cultural values. By degrading salmon habitat, increasing river congestion and emitting both conventional and greenhouse pollutants, this project will certainly lead to measurable economic damage to the State of Oregon. While this briefing identifies and quantifies a number of important risks, much more information will be necessary to estimate the full magnitude of the damages.

The Morrow Pacific project would rely on a combination of coal trains, barges, and ocean-going vessels (OGVs). Trains would transport coal from the Powder River Basin mines in Wyoming to the Port of Morrow in Boardman, Oregon. Coal trains possess numerous and incalculable environmental, social and economic risks such as water and crop contamination, habitat degradation, and disease, which are not covered in this briefing. From the Port of Morrow, the coal would be transported by barge to Port Westward at Clatskanie, Oregon, where it would be transferred to OGVs for transport to East Asia. Though coal barges are generally accepted to be cleaner than coal trains, they also carry their own risks to economy, environment and society. These risks include coal and fuel spillage, collision, grounding, congestion, emissions, habitat disruption, and fish mortality from wake and propellers. Collisions, groundings, spillage and congestion are permanent features of barge traffic, with the Mississippi River providing numerous examples (Plume 2013).

When operating at full capacity, the project would send approximately 50 barges per week down and back up the Columbia River to Port Westward, for a total of 5,029 total one-way barge trips per year (or 2,514 round trips). These barges would be connected to one another in tows of four barges each, for a total of 1,258 one-way tows when the project is at full capacity. From Port Westward, the project would send three OGVs round-trip through the mouth of the Columbia, for six one-way trips per week, or 312 one-way trips per year (Anderson Perry 2012). The project, at full capacity, would transport a total of 8.8 million short tons (8 million metric tons) of coal from the Powder River Basin to be exported to Asia.

Proponents of the Morrow Pacific project claim that coal barges are environmentally safe. Ambre Energy, developer of the project, claims "The processes and technology have proven track records of environmental safety…. (they) are routinely used … for other bulk commodities such as wheat and wood chips." (Ambre Energy 2012, p. 5)

This report demonstrates that in fact, Morrow Pacific would endanger critical fish habitat and water quality, as well as recreational industries and tribal fishing throughout the Columbia Gorge and Western Oregon. The total cost of emissions – both locally and globally – from the additional diesel fuel burned by the barges will be significant. Finally, the number of jobs created by the project is far fewer than would be created by alternative energy, transportation or environmental restoration projects.

This report provides some estimates of the magnitude of the economic risks from Morrow Pacific. It finds that the total value of salmon habitat placed at risk by Morrow Pacific is **$1.5 - 4.5 billion.** Over the 20-year lifetime of the project, the present value of potential direct losses of salmon from just two of the many risks involved - wake stranding and nursery habitat degradation - is **$63 million**, at a 3% discount rate.

The coal barge traffic would also endanger recreational values in the Columbia River Gorge. Over the 20-year lifetime of the project, the present value of Columbia Gorge tourist spending placed at risk is **$746 million** at a 3% discount rate, of which **$223 million** represents labor income to people who live and work in the Gorge.

The risk of barge accidents is substantial; many of these accidents will result in spills of either coal or barge diesel fuel. Based on a study conducted in the Fraser River, the 218-mile stretch of Columbia River barge traffic may suffer **24 total barge incidents/accidents** per year, of which about one incident would consist of a spill of coal or fuel. The results of the Fraser River study, transferred to the Columbia on a per-mile basis, predict that an accident would fully destroy one barge every two years. The need for rigorous modeling of these risks specific to the Columbia River is urgent.

Contrary to the claims of barging advocates, barges produce substantial emissions of both conventional pollutants and greenhouse gases. The annual economic value of the negative externalities produced by the Morrow Pacific coal barges from four major conventional pollutants – SO2, CO, NOx and PM10 – is **$17.85 million**. And the annual emissions of greenhouse gases represent an annual economic loss of **$22.75 million**, by the U.S. government's conservative estimate of the social cost of carbon dioxide emissions.

Finally, the job numbers reported in the economic impact study conducted by ECONorthwest (2012), while not negligible, become much less impressive when compared to sample projects in other areas of the economy. For instance, while the capital investment and operations phases of Morrow Pacific would create **2,162 temporary** and **1,092 permanent** jobs respectively, an identically scaled transportation infrastructure project would create **4,674 temporary** and **1,905 permanent** jobs.

This briefing recommends that the State of Oregon conduct a **full economic cost-benefit analysis** to build on these estimates, and refine its understanding of the total impacts of coal barges before making an informed decision about whether to approve the project.

Specifically, we recommend that the State of Oregon:

- Model the risk of all major categories of coal barge accidents and impacts in the Columbia, including the safety risks to small fishers, recreators, and navigators
- Model the total costs of coal barging, and the number of jobs lost or at risk from barge accidents and barge-related pollution
- Undertake an ecosystem services analysis of the Lower Columbia River basin, to identify the total economic value (TEV) of the river ecosystem to human communities, including both market

and non-market values associated with fish and wildlife habitat, recreation, transportation, biodiversity, and local and regional cultures

II. Risks to Salmon and Steelhead Habitat

The Morrow Pacific project places vital salmon runs in jeopardy. According to the Biological Assessment of the Morrow Pacific Project conducted by Anderson Perry and Associates (2012), the project is considered "Likely to Adversely Affect" Chinook, chum, coho, and sockeye salmon; steelhead; bull trout; green sturgeon; and eulachon in the Columbia, Willamette and Snake River basins. The economic value of habitat for salmon and other major fish species is large. Salmon, in particular, provide a key biological, economic and cultural resource; salmon fisherman, Nisqually elder and activist Billy Frank Jr. has called salmon "the measurement of well-being for all life in the Pacific Northwest". This section provides two sets of estimates of potential losses of salmon habitat: first, the total value of salmon resources placed at risk by the Morrow Pacific project; second, the estimated direct losses of salmon from increased coal barge transport.

A. Total Resources At Risk

While there is no up-to-date comprehensive valuation study of Lower Columbia River salmon habitat to date, we can use valuation estimates from older Columbia River economic studies to provide a ballpark. The value of salmon habitat tends to be divided into three portions: commercial, recreational, and passive (non-use) values. Low and high estimates for these values are summarized in Table 1 below.

Table 1. Total Economic Value Estimates for Columbia River Salmon

	Low ($/fish)	High ($/fish)	# fish	TOTAL
Commercial	$58.17	$88.30	-	**$4.955 million**
Recreational/Sport (2013)	$78.90	$226.26	32,109	**$4.47 - $8.19 million**
Non-Use (2013)	$1,824	$2,890	1,552,974	**$2.83 - $4.49 billion**
Non-Use (20-Year Average, 1993-2013)	"	"	826,540	**$1.51 - $2.39 billion**
TOTAL				**$1.52 - $4.5 billion**

For commercial fishing values, we draw upon the landings data reported by ODFW (2014), who report a total of $4.955 million of salmon, steelhead and sturgeon caught on the Columbia River in Oregon in 2013. The per-fish values are updated from IEAB (2005) and Radtke and Davis (1995).

For recreational values, we draw from the estimates of total recreational willingness to pay (WTP) studies, which measure the total amount that a recreational angler is willing to spend in order to catch each fish. The primary studies on this topic are by Olsen *et al* (1990) and Meyer *et al* (1983), updated to 2007 dollar values by Helvoigt and Charlton (2009); we update these estimates further to 2014 values using the Consumer Price Index (CPI). Olsen *et al* (1990) estimate that recreational anglers' willingness

to pay for Columbia River salmon is $69.83 per fish ($78.90 in 2014 dollars); Meyer *et al* (1983) derive a corresponding estimate of $200.23 per fish ($226.26 in 2014 dollars). We use these per-fish values as our low and high estimates for the total value of sport-caught salmon. For steelhead, we use the same authors' per-fish estimates of $202.39 (Olsen *et al* 1990) and $320.28 (Meyer *et al* 1983).

ODFW (2013) reports 32,109 total salmon and steelhead caught by sport fishermen in the Lower Columbia between the Longview Bridge and the McNary Dam in 2013. Based on the above estimates, these fish are worth between **$4.47 and $8.19 million**. These figures represent low and high estimates of the magnitude of the recreational fishing resources at risk from expansion of coal barge transport.

For non-use values, we make use of existing studies of citizen willingness-to-pay (WTP) for restoration to estimate the total economic value that would be lost if the Columbia River salmon fishery were destroyed. Goodstein and Matson (2007), following Layton *et al* (1999), estimate the non-use economic value of Columbia River salmon habitat as **$2,890 *per fish***, summed over two million Oregon and Washington households. This measure represents Oregon and Washington residents' *total* willingness to pay to restore salmon habitat by one additional fish.[1] Notably, the vast majority of these residents do not fish for salmon in the Columbia; salmon possess a non-use, non-market value to the population as a whole that far exceeds both their market price and their value to recreational anglers.

We can use the Layton *et al* (1999) value estimate to provide a ballpark figure for the total value of the salmon resources at risk from Morrow Pacific. The fish counts conducted by ODFW (2013) at Bonneville Dam indicate the passage of 1,552,974 total salmon during the year 2013; the total value of the 2013 salmon runs is thus **$4.49 billion**. [2] These values represent the benefit from restoring habitat for additional salmon. For our low estimate, we use Loomis's (1999) estimated average total social value of Rogue River salmon at $1,824 per fish. By this estimate, the total value of the 2013 Columbia River salmon runs is **$2.83 billion**.

2013 was an unusually large salmon run; fall 2013 Columbia Chinook salmon run of 953,222 was the largest on record. Thus, we also report the 20-year average total salmon run over the period 1993-2013, of 826,540 fish. This average salmon run is worth **$1.51 - $2.39 billion** by the non-use values given above.

Summing across low and high values, we arrive at a total estimate of annual sport, commercial and non-use value of Lower Columbia River salmon habitat of **$1.52 - $4.5 billion**. Notably, this estimate leaves out the priceless heritage, spiritual and bequest values of tribal fishing grounds.

B. Potential For Direct Losses

[1] Each individual household's willingness to pay to restore habitat for a single fish is $2,890 / 2,000,000 = $0.00145, or about .1 cents / fish.

[2] Importantly, these figures leave out the salmon that spawn in the Willamette, Cowlitz and other rivers that will be impacted indirectly by the barges and OGVs from Morrow Pacific.

While it is very unlikely that the entire Lower Columbia River salmon fishery would be wiped out by the Morrow Pacific barge project, it is likely that significant numbers of salmon and other species would be lost to mortality due to construction, barge transport, spills or other accidents as a result of the project. This section provides some basic estimates of the likely values of those losses, wherever data is available.

Ambre Energy contracted a Biological Assessment of the Morrow Pacific project as part of the permitting process (Anderson Perry 2012).[3] The Biological Assessment identifies clear risks to both salmon and steelhead in the Lower Columbia, including:

- Injury or mortality from direct contact with tug, barge or OGVs hulls and propellers
- Habitat disturbance from vessel operation, including wake stranding from OGVs traffic downstream of Port Westward
- Ongoing negative impacts to water quality, substrate at the docks, and food resources

The only impact from the list above that has yet been measured is that of wake stranding, in which the wakes of deep-draft barges strand salmon on beaches. Pearson, Skalsi *et al* (2006) measured wake stranding from barges at three points along the Lower Columbia River. They measured 46 total stranding events during 126 vessel passages. The mean number of stranded fish per event, across the three measurement points, was 11.3, for a total of 520 stranded fish, of which 442 (85%) were some species of salmonid.[4]

Wake stranding is most likely to occur with the deep-draft, ocean-going vessels (OGVs) from Port Westward to the mouth of the Columbia. At full capacity, Morrow Pacific would send three OGVs round-trip through the mouth of the Columbia, for six one-way trips per week, or 312 one-way trips per year (Anderson Perry 2012). These 312 vessel passages per year would thus, by these estimates, lead to an average increase in 113 wake stranding events per year, leading to the stranding of 1,287 additional fish, of which 1,094 would be salmonids.[5] The large majority (if not all) of these salmon would be juveniles; assume 10% of these juveniles survive to maturity. Using Meyer's (1983) estimates of sport fishers' willingness to pay for each salmon caught, the OGV-related strandings would lead to losses of **$24,753 per year** in sport fishing values alone. Using Goodstein and Matson's (2007) estimate of per-fish total social willingness to pay for habitat restoration ($2,890/fish), the strandings would lead to total losses of **$316,166 per year** in non-use values.

These values add up over time. Table 2 below reports the number of salmon lost by wake stranding alone over a 20-year timeframe, and the present value of those salmon at alternative discount rates. A discount rate is simply a percentage by which each successive year's dollar values are worth less than

[3] Since Ambre Energy chose the contractor with whom to work, we cannot view this as a fully independent assessment; nonetheless, this study contains the best information publicly available.
[4] A recent study by USGS (2013) has pointed out that these estimates are conservative, given that the authors only used three out of many possible locations to measure stranding.
[5] These data refer to the ocean-going vessels (OGVs) only; there is no data on the wake stranding impacts of the barge tows.

the previous year's. A low discount rate is more appropriate for natural capital values, such as salmon, than a high discount rate, since human beings require the benefits of ecosystems to last indefinitely. Given a 3% discount rate, the 20-year present value of the lost Columbia River salmon to sport fishers alone is **$368,260**. The 20-year present non-use value of that salmon to all Pacific Northwest residents in the aggregate is **over $4.7 million** at a 3% discount rate.

Present Value of Lost Salmon from Wake Stranding						
	Discount Rate	**# of Salmon Lost**	**Sport Fishing Values (Low)**	**Sport Fishing Values (High)**	**Non-Use Values (Low)**	**Non-Use Values**
Annual	-	1,094	$8,632	$24,753	$199,546	$316,166
20-Year	5%	21,880	$107,569.56	$308,475.15	$2,486,779.24	$3,940,127.20
	3%	21,880	$128,417.30	$368,259.81	$2,968,734.65	$4,703,751.72
	1%	21,880	$155,763.08	$446,678.76	$3,600,910.69	$5,705,390.30

Morrow Pacific will also station forty-eight barges per week at the edge of a recently restored salmon nursery at Crims Island, jeopardizing the $2.2 million restoration project.[6] Collision, grounding, wake stranding and spills of coal and fuel would all significantly negatively impact the nursery. Haskell and Tiffan (2011) monitored the restoration site from 2004 to 2009, developing an estimate of the impact of restoration on salmon populations. They extrapolated subyearling salmon populations of 11,613 – 13,962 per year in the restored site, versus 404 – 635 subyearlings in the reference (control) site, for an annual restoration impact of 10,978 – 13,558 subyearling salmon. Were 10% of these fish to survive to maturity, losing the restoration site completely would amount to losses of **$86,616 - $306,736 per year** in sport catch values and **$2.0 - $3.9 million per year** in non-use values. The present value of these values over 20 years at a discount rate of 3% is as high as **$4.6 million** in sport fishing values and **$58.3 million** in non-use values.

Table 3. Present Value of Lost Salmon Nursery, Crims Island (Assume 10% SAR)						
	Discount Rate	**# of Salmon Lost**	**Sport Fishing Values (Low)**	**Sport Fishing Values (High)**	**Non-Use Values (Low)**	**Non-Use Values (High)**
Annual	-	10,978-13,558	$86,616	$306,763	$2,002,387	$3,918,262
20-Year	5%	219,560 - 271,160	$1,079,432.05	$3,822,948.87	$24,954,170.47	$48,830,205.22
	3%		$1,288,633.61	$4,563,863.40	$29,790,465.23	$58,293,844.40
	1%		$1,563,041.19	$5,535,713.52	$36,134,184.28	$70,707,204.46

Adding together the sport fishing and non-use values of the salmon estimated to be lost from wake stranding and habitat degradation, we arrive at the range of values presented in Table 4 below. At a 3% annual discount rate, the 20-year present value of lost sport fishing values from wake stranding and degraded nursery habitat is as high as **$4.93 million**; the corresponding non-use value is **$62.97 million**.

[6] The project was managed by the Bonneville Power Administration and Bureau of Reclamation, and monitored by the U.S. Geological Survey (Haskell and Tiffan 2011).

Table 4. Total Values of Lost Salmon from Wake Stranding and Lost Nursery Habitat						
	Discount Rate	**# Salmon Lost**	**Sport (low)**	**Sport(high)**	**Non-use (Low)**	**Non-use (High)**
Annual		12,072 - 14,652	$95,248.08	$331,516.15	$2,201,932.80	$4,234,428.00
20-Year	5%	241,440-293,040	$1,187,001.61	$4,131,424.02	$27,440,949.71	$52,770,332.42
	3%	241,440-293,040	$1,417,050.92	$4,932,123.22	$32,759,199.88	$62,997,596.12
	1%	241,440-293,040	$1,718,804.27	$5,982,392.28	$39,735,094.97	$76,412,594.76

III. Risks to Scenic and Recreational Values

The Columbia River Gorge, through which barge traffic will pass, is a major cultural resource to the States of Oregon and Washington. White and Goodding (2013) report a total 3.5 million visits to Oregon State Parks in the Columbia River Gorge Management Unit, generating a total of $50 million in visitor spending. Visitor spending in the area alone creates a total of 648 jobs and generates over $15 million per year in labor income. These 648 jobs are permanent; they occur year after year. Moreover, the *non-market values* of the Gorge – scenic beauty, cultural heritage, wildlife, hiking trails, and windsurfing, to name just a few – are likely to be far greater than the tourist spending alone. These non-market values have yet to be fully calculated.

With a near-doubling of coal barge traffic, the scenic and recreational values of the area are placed in jeopardy. The increased river congestion may endanger the value of properties with scenic views of the Gorge. Barge traffic will also damage windsurfing and kiteboarding industries in the Hood River area, which bring $1.7 – 3.9 million in value added per year (Columbia Gorge Windsurfing Association 2012). We do not know exactly how much value added will be lost by the barge traffic. It depends on the windsurfing community's perceptions of increased risk, the ability of windsurfing companies to ensure against those risks, and the average windsurfing skill level in the community.

We can estimate the present value of Columbia Gorge tourism revenues over the projected 20-year lifespan of the Morrow Pacific project to estimate the value of the Gorge as a recreational asset. Table 5 (below) provides these estimates for total spending, labor income, and sales only (excluding park entry fees). The 20-year present value of total spending on recreation in the Gorge, at a conservative 5% discount rate, is **over $625 million**. At a 3% discount rate, the total value of Gorge tourism and recreation spending is **over $746 million**, of which **$223.2 million** represents labor income to people who live and work in the Gorge**.** These estimates represent the value of the Gorge as a recreational and tourist asset. However, they encompass only market-mediated use values; they do not encompass Gorge visitors' total willingness to pay to visit the spectacular region of waterfalls, hiking trails, scenic vistas and biodiversity. These non-market values are likely to be much larger than those presented below.

Table 5. Present Value of Recreational Spending				
	Discount Rate	**Total Spending**	**Labor Income**	**Sales Only (Entry Fees Excluded)**
Annual	-	$50,178,000	$15,003,000	$46,649,000
20-Year	5%	$625,328,791	$186,970,542	$581,349,650
	3%	$746,521,934	$223,206,755	$694,019,325
	1%	$905,489,757	$270,737,431	$841,807,000

IV. Risk of Barge Accidents

Accidents are a perennial risk from coal barge transport, occurring frequently along major rivers through which the fuels are transported. For example, in April 2013, the Mississippi River experienced two major coal barge accidents, in which a total of 38 coal barges sank at two separate locations, one near St. Louis and the other near Vicksburg, MS (Plume 2013). Publicly available data on the total environmental impacts of these accidents is scarce. In this section, we use the results of a risk model of coal barge transport in British Columbia to provide ballpark estimates of the possible risks of Morrow Pacific.

Det Norske Veritas (DNV 2012) estimated the magnitude of risks of coal barge transport along the Fraser River in British Columbia using a computer model called Marine Accident Risk Calculation System (MARCS). Their results can be taken as suggestive of the magnitude of the risks that would prevail in the Columbia, though to derive truly reliable results, a separate modeling exercise must be conducted for the Columbia. Navigational risks depend on six major factors: visibility, wind speed/direction, sea/river bottom and bank conditions, wave height, proportion of open water vs. river water, and the strength of the current.

For the Fraser River coal barge project, DNV (2012) estimated total risks, spillage risks, and barge loss risks of seven major types: collision, structural failure/foundering, fire/explosion, powered grounding, drift grounding, impact at docks, and striking at docks. They estimated three cases, of which two are relevant to the Morrow Pacific project.

Case 2 assumed 640 full and 640 empty barge tows traveling down and upriver, respectively, per year, carrying a total of 4 million MT of coal. While the total number of barge tows in this case is nearly identical to that of the proposed Morrow Pacific project (1280 vs. 1258), the amount of coal is approximately half of that transported by Morrow Pacific (4 million vs. 8 million MT). The authors predicted 2.4 total incidents per year, 0.08 spillage incidents and 0.042 total loss incidents under this scenario. A total loss incident is one in which the barge is damaged beyond repair.

Case 3 assumed 1280 full and 1280 empty barge tows per year, carrying 8 million MT of coal. In this case, the amount of coal transported is the same between the two projects, but the number of barge trips in the FSD project is twice that of the Morrow Pacific project. Under this scenario, the authors predicted 4.92 total incidents per year over a 35 kilometer stretch of river, 0.175 spillage incidents and 0.094 total loss risks (DNV 2012).

The stretch of Columbia River from Port of Morrow to Port Westward is approximately 218 miles, or approximately 10 times longer than the stretch of Fraser River measured by DNV (2012). If we scale up the figures from Case 2 accordingly, we arrive at a prediction of **24 total incidents** per year, **0.8 spills** (almost one spill per year) and **0.42 total barge losses** (just less than one every two years).

The accuracy of these results depends on the degree of similarity between the Fraser and Columbia Rivers. Yet the prospect of one coal spill per year, and one lost (wrecked) barge every two years, is alarming enough to warrant a full modeling study that accounts for the unique conditions of the Columbia River. Further uncertainty exists surrounding the average severity of the environmental and human impacts from accidents, spills and total losses. Given that long stretches of the Lower Columbia are used extensively by tribal, commercial, and recreational fishers, windsurfers and kiteboarders, the consequences of 24 accidents per year could be quite severe in terms of human life and livelihood.

The ecosystem impact of coal spills is poorly understood. In general, it is accepted that spillage of unburnt coal into a water body will reduce biotic growth, reproduction and abundance; elevate toxicity and mortality; and alter population and community structure based on each species' stress tolerance (Ahrens and Morrissey 2005). Reviewing the documented impacts of coal in the marine and freshwater environments, Ahrens and Morrissey (2005) conclude that coal "will have physical effects on organisms similar to those of other suspended or deposited sediments. These include abrasion, smothering, alteration of sediment texture and stability, reduced availability of light, and clogging of respiratory and feeding organs." Published studies of the impact of coal on freshwater aquatic species are very limited, but suggest severe negative impacts on fish populations; a 1937 study of suspended coal in streams in Washington indicated that 0.5 – 2.5 hours of exposure to suspended coal washes was sufficient to kill steelhead and cutthroat trout.

The final and most important major impact of coal barge accidents is loss of human life. Bohnengel (2013) analyzed data on incidence of fatalities from coal mining and refining as well as train, barge, and ocean transport. Based on this analysis, the entire Morrow Pacific project is predicted to result in 7.27 total fatalities per year (the proportion from barging only is not reported).

V. Emissions

Though coal barge transport is often touted as a clean alternative to coal trains, the reality is quite different: coal barges burn diesel fuel, which creates both localized and global pollution. Bohnengel (2013) conducted a life-cycle assessment of the Morrow Pacific Project, determining the total amount of key pollutants emitted during each link of the value chain from mining through ocean transport over a 20-year timeframe. The results of this analysis are given in the two tables below. The first table reports the results from the major non-greenhouse (conventional) pollutants, combined with Mathews and Lave's (2000) median estimates of unit externality costs from these pollutants. The original study was undertaken in 1992 dollars; we convert these to 2014 dollars to obtain a current estimate. According to these calculations, barging alone leads to total non-CO2 emissions costs of **$357,019,280 over 20 years**, or **$17,850,964 per year**. Localized air pollution will endanger the health of Lower Columbia Basin residents, as well as degrading both wildlife habitat and recreational quality.

Table 4. Conventional Pollutant Emission Costs of Morrow Pacific						
Pollutant	Total Emissions (MT)	% Total Emissions from Barge Transport	Barge Emissions (MT)	Unit Dollar Cost of Emissions ($/MT)	Value of Externalities from Barging ($) – 20 Year	Annual Value of Externalities from Barging ($)
SO2	217,000	29%	62,930	$1,800	$189,167,580	$9,458,379
CO	85,000	12%	10,200	$520	$8,857,680	$442,884
NOx	290,000	27%	78,300	$1,060	$138,606,660	$6,930,333
PM10	436,000	1%	4,360	$2,800	$20,387,360	$1,019,368
TOTALS					**$357,019,280**	**$17,850,964**

The second table reports the results from the greenhouse gas pollutants. There are five sources of greenhouse gas emissions: N20, HFC/PFCs, CH4, indirect CO2 and fossil fuel (direct) CO2. Emissions from all five can be measured in the same units; hence we report only the aggregate emissions in metric tons of CO2 equivalent. We use two estimates of the total social cost of carbon: the first, labeled (1), is the U.S. government's official estimate of $33/ton. The second estimate, labeled (2) is the median estimate ($200/ton) from Ackerman and Stanton's (2011) review and refinement of existing climate models. If we use the more conservative U.S. government estimate, lifecycle CO2 equivalent emissions from coal barges associated with the Morrow Pacific project will cost society as a whole **$22,751,947 per year** and the 20-year lifecycle emissions cost will be **$455 million**. Using Ackerman and Stanton's estimates, however, these figures rise to **$137.8 million** and **$2.76 billion**. Unlike the previous emissions estimates, the costs of this pollution will be distributed globally as climate change progresses; hence it cannot be viewed as a risk specific to the project area.

Table 5. Greenhouse Gas Emissions Costs of Morrow Pacific						
Total MT CO2e	MT CO2e Barging Only[7]	Barging % of Total CO2e	Total Lifecycle (20 Year) CO2e Emissions Cost (1)	Total Lifecycle (20 Year) CO2e Emissions Cost (2)	Annual CO2e Emissions Cost (1)	Annual CO2e Emissions Cost (2)
64,269,031	13,789,059	21.5%	**$455,038,947**	**$2,757,811,800**	**$22,751,947**	**$137,890,590**

[7] The greenhouse emissions estimates in this table do not include the emissions from trains or OGVs.

VI. Job Creation Impacts: Modest At Best

ECONorthwest (2012) estimated that the Morrow Pacific project would create a total of 2,100 temporary construction jobs (measured in person-years) and 1,000 permanent operations and maintenance (O&M) jobs in the affected areas around the two terminals. These job numbers may sound promising. But in reality, they are quite low given the magnitude of the project.

We can estimate the number of jobs created by the proposed Morrow Pacific project per $1 million invested, by dividing the job creation figures by the total amount of capital investment in millions. ECONorthwest (2012) divides the project into two pieces, capital investment and operations & maintenance (O&M). Table 6 (below) gives the amount of investment, number of jobs, and job creation per $1 million of each piece of the project, as well as the total. Job creation numbers are limited to those created within the 11-county study area modeled by ECONorthwest (2012).

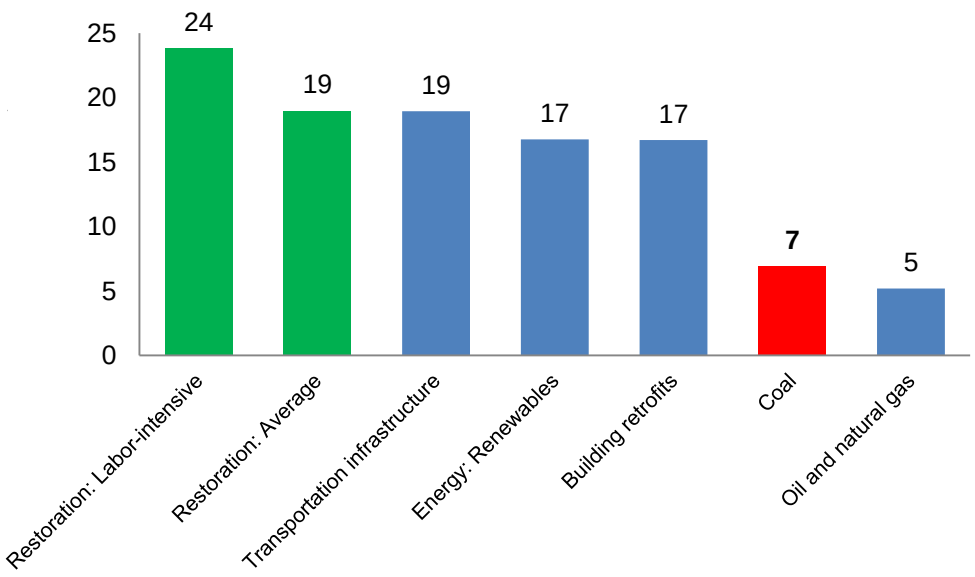
Table 6. Job Creation from Morrow Pacific vs. Alternative Projects

	Investment Expenditures	**Total Jobs Created**	**Jobs Created Per $1 Million Invested**	**Jobs Created by Alternative Project: Transportation Infrastructure**	**Jobs Created by Alternative Project: Labor-Intensive Restoration**
Capital Investment	$245,988,294	2,162 (temporary)	8.79	4,674 (temp)	5,904 (temp)
Operations and Maintenance	$100,279,096 (annual)	1,092 (permanent)	10.89	1,905 (perm)	2,407 (perm)

Alternative projects, such as transportation or water infrastructure, renewable energy, or ecological restoration create many more jobs per unit of investment than fossil fuel-based projects such as Morrow Pacific.

Figure 1 presents data on the number of jobs created, on average, per $1 million invested in a range of different industries. Coal, on average, creates seven total jobs per $1 million invested. Transportation infrastructure creates 19 total jobs, and labor-intensive restoration projects create 24 total jobs (Ecotrust 2014). While Morrow Pacific does create more jobs per unit of investment than the average coal project presented in Figure 1, its job creation potential is still far outpaced by alternatives such as building retrofits, renewable energy, transportation and ecological restoration.

Figure 1: Jobs Created per $1 million by Investment Type. Source: Ecotrust (2014).



Conclusions

In conclusion, we believe that the Morrow Pacific project carries with it a number of important risks to livelihoods, natural resources and economies that must be studied further before an informed decision can be made. First, by increasing barge traffic congestion on the Columbia and increasing the likelihood of spills of coal and fuel, barge groundings, wake strandings and tug propeller activity, the project places at risk one of the world's great salmon fisheries, worth in the billions of dollars in non-use values alone. Second, the project will endanger recreational resources, from windsurfing to scenic beauty, which are one of the primary sources of livelihood for the people of the Columbia River Gorge. We do not have, currently, rigorous estimates of the magnitude of these risks, since they have not been modeled as in the case of other, analogous projects such as the Fraser Surrey Docks. Third, the project will entail significant emissions of pollutants that carry with them measurable economic costs. These costs are significant both locally and globally. Finally, the project will create a smaller number of jobs than would alternative projects of the same size, but in other industries.

We recommend that the State of Oregon undertake a full cost-benefit analysis to generate more precise estimates of both the magnitude of the risks, and the value of the total environmental assets at risk, from Morrow Pacific. On the Morrow Pacific project, the State of Oregon cannot afford to make an uninformed choice.

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