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Hypothesis

Transitions in Urban Waterfronts: Imagining, Contesting, and Sustaining the Aquatic/Terrestrial Interface

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Abstract: Urban waterfronts represent hybrid locations of ecological, economic, and social zones of transition and dispersal, spatially reified between land and water. Yet, through advancements in technology and the emergence of globally linked economies, the structure and function of urban waterfronts as economic and industrial drivers is becoming increasingly complex. As cities seek to redevelop their waterfronts in response to these changes, recent research and scholarship has focused on understanding the ecological, social, and economic benefits derived from urban waterfronts. This research reveals that their benefits are unevenly distributed among local and regional populations as sites of accumulated inequity and inaccessibility that are generative for only a relatively small percentage of the people living in a metropolitan area. Set within this paradoxical nexus, this paper frames a call to scientists, planners, academics, and waterfront activists to expand urban waterfront research from an indicator and benefits model to incorporate three conceptual tools for better understanding key dimensions of waterfront reclamation within the context of green infrastructure research: urban hybridity, functional performance and hierarchies of access. We explore these key dimensions in relation to the waterfront redevelopment of Tacoma, Washington, USA. By acknowledging the hybridity of urban waterfronts, we illustrate that their relative performance and accessibility require ongoing empirical study and practical intervention. Our theoretical explorations plot some of the potential areas of investigation for examining the structural and functional transitions of urban waterfronts as critical locations for green infrastructure development for the 21st century.

Keywords: urban waterfronts; complexity; urban hybridity; functional performance; hierarchies of access

1. Introduction

The rivers, coastal inlets, and bays adjacent to which many of the world's cities are located have always been essential to the very existence of urban life. As locations of intense commodity relations and sites of intersection between the flow of money, regional production, and transportation, urban waterfronts represent points of production, departure, conveyance, and economic return for people and goods. Historically, these characteristics of urban waterfronts and waterways enabled the shift of human settlements from predominantly agrarian to industrial arrangements, giving rise to the urban-century of recent times [1–3].

As waterways have been claimed and enlisted in the work of cities, they have been transformed. Their shape, depth, chemistry, movement, turbidity, and suitability to support biotic life are dramatically influenced by the changes wrought through industrial management and technological control. Urban waterfronts have thus become a "hybrid" or "cyborg" entity as described by critical geographer Eric Swyngedouw [4,5]. They are places representing a fusion of the natural and the social—no longer natural, yet only partially social and technical. They are constructed locations assembled and reified through human

experience and action. In conceptualizing these locations as hybrids, their spatial character is understood as processual, relational, mobile, and unequal [6].

For example, in the waterfront city of Tacoma, Washington in the U.S., the port was initially dredged and constructed over nearly half a century of urban development, transforming the ecologically diverse conditions and culturally significant locations of the Puyallup River delta and estuary into a working, industrial waterfront of intense commercialization and commodity transfer (Figure 1). In recent years, declining spatial needs for traditional maritime uses have resulted in a redevelopment of the historic waterfront focused on more civic and residential development including the recent creation of the Dune Peninsula public park, built on the refuse of previously industrial land uses. These shifts in waterfront development have established a hybridity of land uses and introduced new actors for determining the diverse needs of industrial, commercial, residential, and recreational needs in the contemporary city.

Figure 1. The port city of Tacoma, Washington, located in the Pacific Northwest of the USA on the estuary of the Puyallup River. (Image courtesy of sporcle.com).

This hybridity is common in contemporary urban waterfronts and waterways, identifying them as zones of transition between aquatic and terrestrial ecosystems, maritime and land-based trade, and the urban social and cultural uses of these locations. These overlapping uses create a contemporary social life of urban waterfronts that is inherently complex and dynamic. They are locations of tense economic negotiation and abstruse political entanglements [7,8].

In this conceptual investigation, we frame a call to scientists, planners, academics, and waterfront activists to expand urban waterfront research from an indicator and benefits model to incorporate three conceptual tools for better understanding key dimensions of waterfront reclamation within the context of green infrastructure research: urban hybridity, functional performance, and hierarchies of access. To articulate some of the challenges confronting the design, planning, and regulation of port city waterfronts and waterways, we begin by focusing on two broad issues of concern. They include the overall loss of ecological integrity in these diverse ecotones and the increasingly inequitable distribution of social and economic benefits of these urban land uses.

2. Environmental Impacts and Challenges

It is well-documented that the urbanization of inland and coastal waterways has led to dramatic decline of the functional ecological integrity of major rivers, estuaries, and coastal

bays throughout the world [9,10]. In port cities, this is most evident in the widespread development of coastal estuaries through filling, dredging, and legacy/ongoing industrial pollution. In the Puget Sound Region of the United States in which the port city of Tacoma is located, we see the impact of the roughly 80% loss of estuarine habitat in indicators such as declining eelgrass and shellfish availability, decreasing fish and bird populations, and an overall reduction in water and sediment quality [11]. While urbanization as a regional phenomenon contributes to these conditions through floodplain development, stormwater runoff, flood abatement projects, combined sewer overflows, and pesticide and fertilizer use, early port city development has transformed essential sites of sediment distribution, primary productivity, freshwater and saltwater exchange, and benthic gestation into areas that are now controlled and reconfigured for reliable capitalization [12]. For example, in the Puyallup River system in which the city of Tacoma is constructed, research reveals that of the 58 km of marine shorelines in the basin, only 7% or 4 km are undeveloped, free of bulkhead or other armoring which stabilizes the shoreline against any change or subsidence. In addition, only 3% of the historical extents of estuary remain [13]. The majority of this diverse habitat type has been lost to dredging and port infrastructure development to facilitate commerce and trade. The actions of such development have undeniably deteriorated the ecological integrity and functional capacity of aquatic-terrestrial ecosystems in urban waterways and along their waterfronts.

The nexus between aquatic and terrestrial environments reveals an area of great potential to mitigate urbanization's various, yet extensive, environmental impacts. As the center of the port industrial city, and the confluence of one or more contributing watersheds, development of urban waterfronts has historically compromised the functional ecological capacity of these locations. The environmental challenges facing port cities and their regions straddle a dilemma of feasibility. Is it reasonable to expect cohesive strategies of environmental rehabilitation coupled with urban and regional practices of industrial regulation, stormwater management, and land use reform to offset the historically determined and seemingly irreversible degradation of a region's waterways? That is, the very location and organization of late modern industrial cities may be a bigger problem than is acknowledged by current efforts at environmental mitigation and shoreline restoration, even in their most optimistic and well executed forms. The hybrid character of urban-century port cities may produce damaging environmental and social conditions that exceed the capacity for correction through policy attempts at amelioration. This is an empirical question, approached through the research frames that follow. We acknowledge that an affirmative response is not a foregone conclusion, but rather a pragmatic course of inquiry and action with uncertain outcomes.

3. Social, Economic, and Environmental Benefits

A worsening issue faced by port cities and their regions is the concern of social inequity in the distribution of social, economic, and environmental benefits generated by urban waterfronts and waterways [9]. Alterations to urban waterways wrought by industrialization, and the specific physical geography of their location, have often compromised regional environmental functions to a point that renders them irrecoverable. Historical justifications have centered on economic capital gains and commerce to support community establishment and growth across a region. This is the rationale that we have become accustomed to accepting. However, in the example of Tacoma, many people throughout the urban region reap the benefits in return. A recent economic report for the Port of Tacoma identifies port activities as a major economic driver in the region, supporting employment through direct and indirect means of more than 42,000 people, generating nearly $3 billion (USD) in economic activity, and producing more than $100 million (USD) annually in state and local taxes, which in turn supports basic social and physical infrastructure [14].

Yet, the reality is less sanguine. Globally, port city regions face variegated, but broadly shared trends of rising income inequality, limited access to clean and safe environmental conditions, and uneven availability of public spaces such as parks and esplanades [15].

Socially, the recreational, community, and culturally integrative benefits of urban waterfronts tend disproportionately to accrue to those with the economic resources and residential spatial proximity to access them for leisure, work, and other activities [16,17]. As a place-based amenity, urban waterfronts and waterways are frequently most available to residents and visitors with the leisure time, transportation access, and class-based social practices, such as consumer spending, to participate in their social production [18]. This defines them as both explicit and inadvertent sites of exclusion and segregation, despite their supposedly public character.

Economically, both the transformative effects of port city waterfront redevelopment [19,20] and the trade impacts of high-volume container port traffic [21,22] tend to benefit globally-connected business and agencies, at the expense of less-affluent residents, local workers, and smaller regional businesses. Port infrastructure and waterfront projects involve significant public investment, and the returns are often reported in aggregate, whether in annual cargo tonnage or net private real estate capitalization, as described above with the case of Tacoma, without finer-grained analysis of more meaningful local measures such as the types of jobs created, the diversity of economic activity supported, and specific public resources generated.
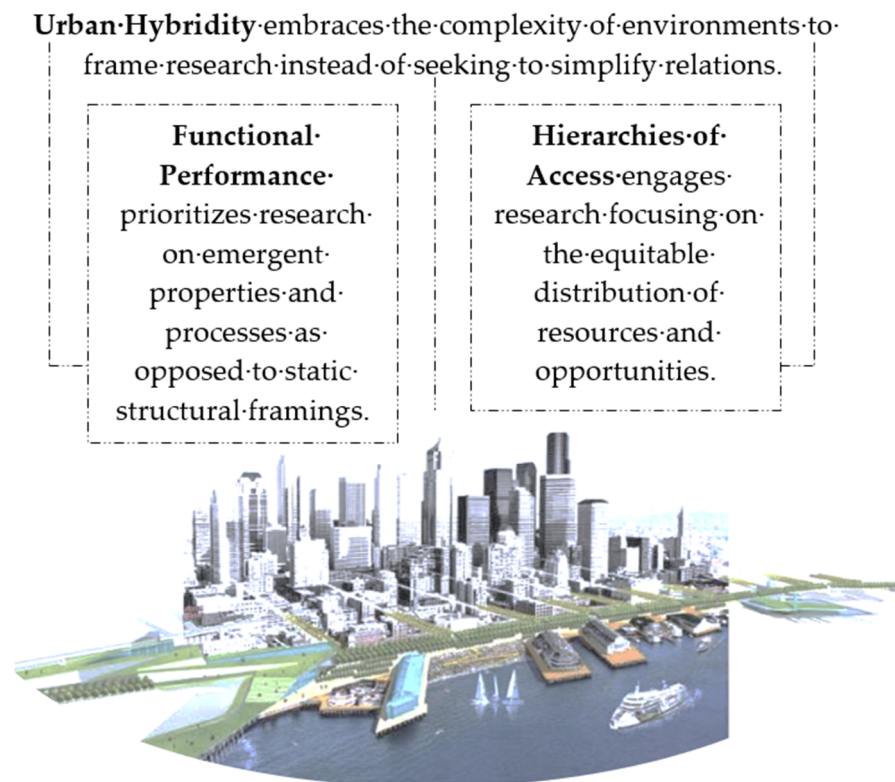
Environmentally, urban waterfronts and waterways are important resources for humans and other species, despite their often vulnerable or compromised ecological integrity. Providing psychological restoration [23], bioregional place identity [24,25], and biological sustenance [26]. Nonetheless, urban natural spaces are not broadly accessible to all inhabitants [27]. The relative sequestering of the port city waterfront's environmental benefits for a relatively limited proportion of residents raises important issues of environmental equity for urban and regional sustainability. In the redevelopment of Tacoma's waterfront development regulations have required new projects to provide public access to the waterfront, and several past industrial sites have been redeveloped as public access. Further, these projects are required to enhance nearshore habitat conditions for aquatic and terrestrial species.

4. Conceptual Tools for Engaged Research

Intentionally seeking to broaden approaches to urban waterfront and green infrastructure research that proactively address a loss of ecological integrity and an increase in inequitable distribution of access and resources requires a reorienting of priorities in building capacity, articulating equitable frames, and ensuring collective agency. We do not argue for approaches that are wholly empirical or entirely circumstantial. Instead, we seek generative approaches that draw upon diverse constructs of knowledge to form practical, flexible, and adaptive frameworks for understanding contemporary transition in waterfront redevelopment, grounded in the contextual conditions of place.

We identify urban hybridity, functional performance, and hierarchies of access as emerging conceptual tools in urban and place-based research that embrace complex arrangements instead of reducing them, prioritize relations instead of structure, and broaden frames of equity to include human and non-human actors (Figure 2). Our method is interpretive and driven by meta-analysis of extant waterfront research, drawing on over five decades of combined research and professional practice, in this area. In this effort, we conducted extensive literature reviews, utilizing grounded sampling across disciplinary perspectives in anthropology, critical geography, heritage studies, urban political ecology, and the allied design and planning fields to assess the core meanings and fundamental precepts of these concepts. We sought both common ground and distinction in their meanings in order frame them within the context of urban waterfront and green infrastructure research. Our goal is to formulate a characterization of waterfront research that responds to the unique demands of port city development in an age of rapid change, technological innovation, and habitat transformation.

Urban·Hybridity·embraces·the·complexity·of·environments·to·
frame·research·instead·of·seeking·to·simplify·relations.

**Functional·
Performance·**
prioritizes·research·
on·emergent·
properties·and·
processes·as·
opposed·to·static·
structural·framings.

**Hierarchies·of·
Access**·engages·
research·focusing·on·
the·equitable·
distribution·of·
resources·and·
opportunities.

Urban·waterfronts·are·locations·of·intense·geopolitical,·
economic,·and·ecological·entanglements·requiring·new·methods·
of·analysis·for·contemplating·their·complex·and·emergent·

Figure 2. Conceptual framing articulating a call for expanded research perspectives to better understand the socio-political, economic, and environmental complexity of urban waterfronts (Image adapted from Field Operations).

In keeping with the emphasis on sustainable cities and waterfronts that orients our work, we build upon the tripartite division of classic sustainability policy and practice (social, economic, environmental) in seeking to identify and classify hybrid waterscapes of human and non-human actors. We further explore opportunities for how they are related and made legible to us in time and space. We argue for engaging in conversations with the uneasy, yet equally empirical bedfellows of positivist natural and social sciences (e.g., landscape ecology, regional economics) and critical approaches to socio-spatial description and interpretation (e.g., critical geography, socio-cultural anthropology).

4.1. Urban Hybridity

As a fundamental precept of this research, we engage the critical notion of urban hybridity as a characteristic conceptual tool for contemplating the complexity imbued in urban waterfronts. Emerging critical and post-structuralist scholarship describes this notion of urban hybridity as a perspective that embraces the complexity of urban environments as locations of intense socio-ecological entanglements often driven by economic and political pressure [28–31]. Their function and related structure cannot be understood as static, but as a living, dynamic entity that is resilient and adaptive to perturbation and change. Eric Swyngedouw writes,

> "the city and the urban process are a network of interwoven processes that are both human and natural, real and fictional, mechanical and organic. There is nothing 'purely' social or natural about the city, even less a-social or a-natural; the city is both natural and social, real and fictional. In the city, society and

nature, representation and being are inseparable, integral to each other, infinitely bound up, yet simultaneously, this hybrid socio-natural 'thing' called city is full of contradictions, tensions and conflicts [1,32]."

While this notion of urban hybridity provides us with a critical frame to contemplate the historical priorities, contemporary structure, and future speculations of urban waterfronts it does little to prioritize research or guide the actions of urban residents, government agencies, or policy for sustainably managing the transition of these environments [33]. To analyze and respond to these challenges and to engage in a notional understanding of waterfronts as locations of urban hybridity, we explore two conceptual tools for contemplating their dynamics, in order to propose and orient a research agenda identifying areas for investigation and action: functional performance and hierarchies of access.

4.2. Functional Performance

Within the context of urban hybridity, functional performance lends itself to the mechanics and activities of the diverse socio-ecological actions that take place on urban waterfronts. From this perspective, we define performance as a set of measures selected and formalized to determine the effectiveness with which actionable solutions to a problem contribute to the effective sustainability of that purpose. It is the operational frame that permits us to characterize the component human and non-human actors, their relations, and predominant patterns of urban waterfront and waterway arrangements.

To measure performance, indicators of success are typically predefined, but are adaptable to changing conditions and unanticipated impacts. This mostly quantitative methodological approach is well defined in the allied design and planning literature and evaluated under the descriptive terms of building and landscape performance [34–36]. It is an approach that is at once deeply empirical and analytical, examining, comparing, and distinguishing between spatial typologies and distinct instantiations of social-ecological systems as they are enacted and established in different port cities [37,38]. Yet, they are also intentionally performative, enlisting a perspective that emphasizes the continually provisional practice of assembling and re-assembling urban space [6,31]. In the Puget Sound Region of the USA where Tacoma is located, an example of a common indicator for success in design is in the linear meters of waterfront reconstructed to provide nearshore habitat for fish and other aquatic species.

On the one hand, to perform implies that it can be done "well," for a particular and expected dependent variable or outcome. This is the connotation of a social, economic, or environmental arrangement that is delimited and characterized for evaluation through scientific methods and modes of measurement. Such studies provide substantive findings that tell us whether a site is or is not performing along a particular dimension, as measured by specific values and indicators [39]. The actors involved—human and non-human elements of a performance typology—are independent variables, relations between them are knowable causal pathways, and key social, economic, and environmental outcomes emerge from a multivariate equation that can be reliably modeled and measured.

On the other hand, variables of performance are complex, relational, and adaptive to changing conditions. Relations between actors—human and non-human elements—reveal the very interdependence of their variability; associations change, elements resist or become available, intentionality or chemistry or technology (among other things) intervenes to support or deny a durability in waterfront and waterway performance. Understood thus, this performance is expected to be both less, and more, than the evaluative approach described above. It is expected to be less because no typological model can fully capture the myriad complexities and contingent relations of port cities, enacted in space and time. It is expected to be more because in the chronic uncertainty of relations among social, economic, and environmental actors is the quiet promise that they can be performed more effectively, to yield different outcomes of more sustainable configurations.

Questions of functional performance help us to characterize social, economic, and environmental patterns. What arrangements are being enacted? Who or what is involved? Also,

how are the mechanics or typological configurations and associations of the waterfront organized? Within this context, typological configurations of social performance (parks, trails, open shorelines, docks), economic performance (shipping, trade, tourism, retail), and environmental performance (species diversity and biological health) can be assessed. Our utilization of functional performance acknowledges that some uses will be prioritized over, or negotiated against others, and helps to illustrate, in empirical terms, the trade-offs involved. Such an approach requires a more detailed investment into understanding the hierarchies of access for the actors and stakeholders involved in the visioning, making, and sustainable management of urban waterfronts.

One potential approach to engaging functional performance research is through advocacy. Research into the performative aspects of advocacy can reach beyond common frames of political economy driven by indicators of progress and success to reveal underexamined ethnographies of material, place, and social power. Advocacy for previously tempered voices and perspectives has the potential to expose "added matter for a politics of social recognition and justice—matter that might prove to be more than marginal. [40] (p. 156)". In this context, political advocacy emerges as a primary driver for change with capacity for new assemblages in both material and cultural practices that shape the transitions of urban waterfront conditions. A multi-voice perspective of political advocacy enables the establishment of policy and processes to govern opportunities that deepen the values attributed to performance while broadening the sphere of potential influence to a more diverse set of actors and stakeholders to frame the conditions of sustainability of waterfront locations. In Tacoma, the waterfront redevelopment has incorporated a wide range of stakeholder perspectives from industry and commerce to local residents. Most significantly, the contemporary overall planning and individual projects are informed and guided by the perspectives of the Puyallup Tribe, the indigenous peoples of this area who were not engaged in most development decisions in previous decades.

Who or what benefits from policies and actions to transition sustainable urban waterfronts will be relevant for every performance type of green infrastructure and waterfront location, or for every specific instance of each type. The performance types, whether advocacy or other types, their component actors, relations, and key outcomes are the variables that require further definition, research, and analysis. However, by articulating and focusing on the patterned, distributional, and knowable empirical dynamics of port city waterfronts, functional performance measures help foreground specific social equity issues that are essential for the sustainable development of urban waterway and green infrastructure spaces.

4.3. Hierarchies of Access

The often under-developed area of sustainable development and equity research requires that functional performance through the frames of economic prosperity and environmental benefits are widely distributed and integrated throughout the social systems and physical places through which most urban residents live their lives. There is no guarantee that gains made in improved environmental conditions and new forms of economic productivity will simultaneously increase urban social equity and in fact, significant empirical evidence suggests a growing predictability and intensification of a dislodging of social equity goals, despite the growing prevalence of equity related issues in policy discourses of sustainability [41–43].

A more intentional emphasis on social equity in sustainable development research and practice requires a focus through which urban development can be problematized and approached more critically and pragmatically, such as with the type and availability of work [44], characteristics and goals of urban form [45], understandings of social capital [46], and the strategic use of indicators to strengthen social outcomes [47]. In this approach to sustainable urban development research, we align hierarchies of access as a normative complement to questions of functional performance. We define hierarchies of access as a means of enabling the ability, right, and permission for engagement of all the actors and

stakeholders impacted through the process of waterfront redevelopment, regardless of whether they are human or non-human. While we recognize that hierarchy is commonly established through political and social power dynamics, this approach adds an explicit equity frame, surfacing the values that underpin performance-based typological distinctions among different waterfront configurations. It affords agency to all actors and stakeholders impacted by physical and relational transitions to the waterfront.

One example of research engaging hierarchies of access is in the growing body of knowledge in embodied experiences, investigating orientations connecting human experience and consciousness to material and spatial forms. Emerging research in anthropology, phenomenology, and environmental psychology examines how and why individuals and communities ascribe meaning to, and form attachments with, particular places. This work is directly related to the potential of community-based planning practices in supporting urban revitalization efforts [48]. As environmental psychologists, Lynne Manzo and Douglas Perkins [49] (p. 347) write, "Residents' ability and willingness to address local problems are influenced by their emotional commitment to their community places." Exploring connections within and among diverse communities and stakeholders enables greater opportunities for sustainable planning practices to more greatly comprehend complex emotional attachments to place [50]. As such, these practices can in turn support a more comprehensive framing of physical access and belonging, establishing urban waterfronts as democratic spaces supporting a broad array of urban needs. In the Tacoma case, the incorporation of diverse stakeholder perspectives is best exemplified in the community engagement practices used in the design of Dune Peninsula park, with the direct intention of providing public access to the waterfront for the greatest number of engaged constituencies possible.

Another example is in emerging investigations into multi-species conviviality. From its etymological foundations, the meaning of conviviality attends to inquiries of how to live well together providing a broadening of perspective with the potential for "richer and more responsive invention, speculation, and proposing" [51] (p. 93) in which urban communities may cultivate a deeper understanding of the world around them. Research into interspecies conviviality in planning and design, thus, examines the potential to transcend anthropocentric and instrumentalist approaches to engage in practices that provide value and agency to non-human actors and stakeholders in the planning process [52,53].

We recognize that the past half century of urban policy and planning practices have identified the potential benefits, often framed through ecosystem services, of approaches that acknowledge the importance of interspecies conviviality with humans, such as green infrastructure policies for preserving and improving urban open spaces, enhancing urban canopy cover, and providing alternatives to traditional practices for managing stormwater. Yet, the conditions of such policies maintain a framing of the "other" in service to human communities, and do not fully engage the potential enabled by a perspective of urban hybridity. Providing an interspecies ontological framing enables policymakers, planners, and stakeholders of urban waterfronts and green infrastructure projects to "devise new procedures, technologies and regimes of perception that enable us to consult nonhumans more closely, or to listen and respond more carefully to their outbreaks, objections, testimonies and prepositions' in imagining politics anew" [54] (p. 107).

The question of who or what benefits from the waterfront as a designed, green infrastructural environment, is foregrounded in our agenda as an essential area of inquiry. We seek an enumeration of competing claims on the waterfront as an urban space, and greater understanding of their enactment and durability over time in particular places. In this, hierarchies of access should be examined through analysis of performance typologies as they engage discourses of development, politics, design, and sustainability. While we recognize that many of these issues directly relate to governance structures, institutional norms, and regulatory policy that reach far beyond the scale of the waterfront, research into hierarchies of access overlay a complementary, and explicitly normative perspective on performance. Who or what benefits from the arrangements identified, within social, eco-

nomic, and environmental ecosystems? How are such distributions to long-term, systemic capacities for urban and regional sustainability? What are the distributive implications of different performance typologies, for broader global and regional patterns of urban social-ecological systems?

5. Conclusions

As new assemblages of urban waterfronts are enacted and made durable, there are residents, communities, species, and organizational entities that benefit from these changes. There are also those that do not, losing political and economic power, natural and cultural resources, and pathways to urban and regional sustainability. We seek a rigorous evaluative lens and the addition of conceptual research tools for sustainable urban waterfront development, inverting and deepening preliminary assessments of social, economic, and environmental gains. Such studies have the potential to broaden the scope of urban waterfront and green infrastructure research to interrogate the complex aspects of hybrid relations, functional performance, and hierarchies of access within these locations, such as our example of the redevelopment of Tacoma's waterfront. In particular, these approaches may build capacity and offer agency for those who may not have an immediate or formal presence in the institutional patterns and decision-making processes through which urban waterfronts are designed and used (Table 1).

Table 1. Conceptual research tools for a more engaged and responsive approach to urban waterfront and green infrastructure research.

Conceptual Tools for Research	Definitions	Potential Contributions
Urban Hybridity	Characterizes urban complexity as irreducible, relational, and both natural and social	Broadens capacity for research to bridge inductive and deductive reasoning
Functional Performance	Measures determining the effectiveness of actions for specific purposes	Offers strategies for comparability across cases
Hierarchies of Access	Enables the ability, right, and permission for engagement of all actors	Provides relational understanding of actor priorities and contextual conditions over time

As a preliminary contribution of how functional performance and hierarchies of access within the context of urban hybridity might translate to research on urban waterfronts and green infrastructure spaces, like the port city of Tacoma, we offer these ideas as an initial framing of engagement. They are based on a detailed review of diverse scholarship on emerging trends in place-based research, and intended for subsequent expansion, refinement, and consideration through a wide range of disciplinary perspectives and meta-analysis of the urban waterfront and green infrastructure literature.

We anticipate these conceptual tools for research will serve to preserve the inherent tensions in our understanding of how urban waterfronts perform. The experimental capacity of such research can provide a means of knowledge production and initiate transformational action and intervention.

In developing provisional and systematic knowledge of urban waterfront and green infrastructure conditions, we acknowledge the institutional and cultural patterns that serve to hold these conditions in place. We further extol the need for ongoing action research, focused on political advocacy, embodied experience, and interspecies conviviality. We provide these three areas as examples of potential research connections, recognizing that there are limitations to these approaches as there is in all research engagements. Our intention here is to expand the current scope of research perspectives to diversify inquiry into urban waterfront and green infrastructure research beyond typical deductive framings that focus on the more readily accessible measures of broad-based indicators for economic impact.

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