How the biophilic design social movement informs planning, policy and professional practice

Jana Söderlund[1,2]* and Peter Newman[1]

Abstract

Background: A new social movement called *biophilic design* has emerged over recent decades to enable greater connection between nature and urban populations to make biodiversity and natural systems a part of daily life in cities. Understanding the origins of this social movement can inform further progression, implementation and planning of biophilic design.

Results: The research methodology of immersion and heuristic inquiry within the social movement was used to create interviews with key people in the social movement's origin and subsequent delivery. The results are presented using the three stages of a social movement: emergence, coalescence and mainstreaming. In each stage there are particular motivators and drivers that provide impetus to the movement which are outlined based on the responses of the participants.

Conclusions: The results were applied to the three stages of the social movement and translated into a framework of ten actions for mainstreaming the implementation of biophilic design into urban planning and policy as well as into professional practice.

Highlights

• Social movements progress through three stages: emergence, coalescence, mainstream.

• Biophilic design emerged as a social movement primarily driven by five motivators.

• Successful trials, multiple benefits and strategic policy helped the coalescence.

• Learning from these motivators and drivers assists with creating a framework for mainstreaming.

• Multi-sector collaboration including government is needed for urban planning and policy delivery structures.

Keywords: Social movement, Biophilic design, Urban planning, Urban policy

Background

Biophilic design suggests there is an innate human need to affiliate with nature in the built environment. Although a relatively recent concept (see below) it appears to have become a social movement, defined as a.

'loosely organized but sustained campaign in support of a social goal...they result from the more or less spontaneous coming together of people whose relationships are not defined by rules and procedures but who merely share a common outlook on society.' [22]

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*Correspondence: j.soderlund@biophilic.solutions

[2] Biophilic Solutions, Perth, Australia
Full list of author information is available at the end of the article

This paper examines how the biophilic design social movement has happened and what can be learned from this by other cities and places wanting to have a similar process.

Social movements begin with a core group of people uniting with a shared social goal, to enable some kind of change [11]. They are categorised into three stages of development: emergence, coalescence and mainstream [7]. In order to understand biophilic design as a social movement an immersive journey of heuristic inquiry was undertaken. The paper will examine how this was done and the results that were found to fit into this three-stage development of a social movement. It then suggests ways forward to mainstream the social movement.

These understandings of what has driven and motivated the progression and implementation of biophilic design, enable a framework to be created of actions for mainstreaming biophilic design. This framework can be utilised by governments, professional groups and non-government organisations, to inform strategic urban planning, policy and development within cities.

The emergence of the biophilic design social movement

In the early 1960s, psychoanalyst Fromm [8] argued that urban dwellers were facing a disconnect from nature and loss of the psychological benefits that can ensue from a healthy human-nature relationship (1964). To follow a positive, progressive pathway in life Fromm proposed that a love of life was necessary. He coined the term 'biophilia' to express this human-nature connection, with 'bio' meaning life and 'philia', the opposite of 'phobia', meaning attraction or love [8]. Very few academics or professionals in urban development appear to have used the term until prominent sociobiologist, Edward Wilson, utilised Fromm's term biophilia to describe emotions which were provoked during a period of immersion in nature [26]. Wilson defined biophilia as the "innate tendency to focus on life and life-like processes" ([26], p.1). His book, *Biophilia*, presented a similar perspective to earlier conservationists such as Naess [18], though with a perception of the human connection to nature as an innate, biological need, not solely an inherent interdependence, and therefore it was a necessary part of everyday life, even in cities which are inherently designed to provide a degree of separation from nature.

However, this idea of a biological need for nature which influences behaviour was still not clearly a part of academia or urban professional practice until the early 1990's when a group of interested scholars met to discuss the concept, which included Stephen Kellert, a Harvard socio-biologist. Here were the first stirrings of a social movement with people uniting with a shared ethical interest. From this gathering, a hypothesis emerged, 'the Biophilia Hypothesis', with a book of the same name edited by Kellert and Wilson [16]. The hypothesis formalised Wilson's earlier theory and proposed that biophilia, a love of life, is inherent and part of our species' evolutionary heritage ([12], p. 21). *The Biophilia Hypothesis* received a positive reception amongst scholars but it was not taken up by urban professional practice until some years later, in 2007, when Kellert brought together a diverse group including academics, industry representatives and real estate investors who had shown a shared interest in increasing the opportunity for nature to find expression in urban design. Many ideas were discussed and design principles emerged. These resulted in a book called *Biophilic Design* [15] which introduced the concept and rationale for nature no longer being minimised in cities but recognised as having much to offer in everyday urban life and therefore design [25]. It was at this gathering that the social movement of biophilic design firmly begun and gained momentum, aided by the publishing of the *Biophilic Design* book. Biophilic design was summarised as "the expression of the inherent human need to affiliate with nature in the design of the built environment" ([14], p.viii).

One of the people involved in the Biophilic Design book was Tim Beatley from University of Virginia, who then began to draw together ideas from around the world and from other academic literature to show that the concept needed to be mainstreamed in cities. His book *Biophilic Cities* in 2010 and the subsequent book *Handbook of Biophilic City Planning and Design* in 2017 are accompanied now by a website that services a Biophilic Cities Network. This network has been created to support a growing social movement of cities around the world that are making biophilic design part of their policy framework and practice.

Authors of the *Biophilic Design* book recognised the need to define the dimensions of biophilic design as the beginning of a tool kit for urban designers and developers. Heerwagen and Gregory [9] categorised seven major attributes whereas Kellert [13] listed six elements with 70 design attributes. Ryan et al. [20] refined these design elements of biophilic design with supportive qualitative and quantitative research in both the physiological and the psychological. Browning, recognising previous design attribute lists were unwieldy and potentially confronting for urban designers, consolidated the design attributes to the 14 patterns within three categories shown in Table 1.

Global examples of biophilic design, set out by Tim Beatley and included in the Biophilic Cities website, demonstrate that in many instances the initiative is not purely a functional response to a city's sustainability challenges. There is a motivation beyond the function. Indicators are

Table 1 Patterns of biophilic design

NATURE IN THE SPACE	NATURAL ANALOGUES	NATURE OF THE SPACE
incorporation of plants, water and animals into the built environment, especially with movement.	one degree of separation away from true nature; patterns and materials that evoke nature.	the way humans respond psychologically and physiologically to different spatial configurations.

1. Visual connection with nature – plants inside and out, green roofs and living walls, water, nature artwork

8. Biomorphic forms and patterns – organic building forms, structural systems (savannah effect),

11. Prospect – views, balconies, 6 m and above focal lengths, open floor plans

2 .Non-visual connection with nature – sun patches, textured materials, bird sounds, weather, nature scents

9. Material connection with nature – wood, earth and stone construction, natural colours,

12. Refuge – protected spaces, overhead canopies or lowered ceilings, places providing concealment

3. Non-rhythmic sensory stimuli – clouds, shadows, nature sounds, water reflections

10. Complexity and order – fractal patterns, sky lines, plant selection and variety, material textures and colours

13. Mystery – winding paths, obscured features, flowing forms

4. Access to thermal and airflow variability – shade, radiant heat, seasonal vegetation

14. Risk/Peril – floor to ceiling windows, water walks, high walk ways

5. Presence of water – rivers, fountains, water walls, ponds, daylighted streams

6. Dynamic and diffuse light – light from different angles, ambient diffuse lighting, circadian lighting

7. Connection with natural systems – seasonal patterning, wildlife habitats, diurnal patterns

Adapted from [20]

there that a shift in the approach to the human-nature urban connection has occurred to motivate this set of actions. The origins of biophilic design and the fact that it signifies a social shift in thinking contribute towards defining it as a social movement and is paving the way for a redefining of *Homo Urbanus'* relationship with nature, utilising the term biophilia introduced by Fromm in the 1960s.

Research framework

Social movements have been studied since the French revolution and era of intellectuals and philosophers such as Kant, Rousseau and Hegel, but Lorenz Von Stein is given credit for introducing the term [3, 5]. The changing nature of social movements in a digital age of social media has led to new and varying images and theories of social movements [21]. The social movement theory of James Jasper [11] has been adopted as the framework for this study as it provided a basis for how rapid transition from idea to movement can happen.

Jasper considers that the emerging features of current social movements are where people are being driven by empathetic connection to the world around them, through cultural meanings and moral intuitions (Jasper, personal communication, 2015). He outlines three categories of components of contemporary social movements: micro-foundations, strategies and emotions. He also outlined four features which delineate social movements: intention, coordinated action, persuasive tactics and that they are sustained over time.

Social movements can also be viewed as progressing through stages [7, 11]. We have condensed these into three stages and suggest that social movements are generated internally and are then increasingly externalized in these stages:

- Emergence – where people with similar moral visions and emotions come together to plan strategies for change. This stage involves the internal motivators.
- Coalescence – clear strategies have emerged, leaders have emerged and the movement is gaining momentum. This stage reveals the drivers to start change.
- Mainstream – the philosophy of the movement is adopted and appearing in everyday literature, policy and other mainstream initiatives. In this stage the policies for implementation are formed and delivery is underway in numerous places.

Beyond the stages there are also components that help analyse social movements. Utilizing the identified components of social movement theory as outlined by Jasper [10, 11] and Christiansen [7] provides a framework for analysis of the social movement of biophilic design. This framework was utilized throughout the immersive journey in interviews with key players in Australia and North America.

Where encountered, the following components were identified:

Players – the interviewees
Arenas – where the players are situated: academia, government, industry (biophilic design industry and profession) or civic
Strategies – what they are using to implement biophilic design: policy, research, application, innovation etc.
Motivators and drivers – what urges the players to be involved in biophilic design initiatives
Stages – emergent, coalescent or mainstream
Barriers – any difficulties which players have encountered in their journeys.

Research methodology

The research involved two Australian and 28 North American interviews, in ten cities, of the leaders, the forerunners and the local champions of biophilic design in their city. Details of these interviews are provided in Söderlund [24] and the 28 individuals interviewed are listed in the Acknowledgements.

The interviews utilized a heuristic inquiry framework of semi-structured conversations that were structured sufficiently to obtain core information but allowed to 'ramble' to a natural completion. This encouraged passions and emotions to be revealed and a deeper exchange between the interviewer and the interviewee to take place. Each conversation or interview resulted in a tabular analysis at the end with a snapshot of the extracted components. This analysis is based on two key principles of doing this kind of qualitative research:

1. The extraction of the emergence motivators, coalescence drivers and mainstreaming policy implementation was based on word usage and responses to direct questioning. Literature research provided a list of rationales motivating or hindering biophilic design initiatives plus key words associated with these [23]. Where these occurred in an interview it was noted and they were listed in the interview matrix. Reflection on the written interviews revealed any other words which were frequently used in discussion around motivators, drivers and barriers. At the conclusion of the interviews the phrases and words which compiled the matrices were listed and a word frequency analytical tool used to reveal the common

motivators, drivers and barriers. The motivators and drivers were then themed.

2. In all qualitative research, especially with conversations, there is a certain amount of bias as the process relies on the researcher's perceptions and the focus that has been chosen to interpret the data. The interviews were recorded as well as extensive notes taken so there is accuracy in what was spoken and the words which were used. As a result there are word usage patterns that emerge from all the interviews and these have been used to frame the analysis.

The results are set out in the next sections. Compiled matrices from the Australian and global interviews contained comments which expressed the motivations as experienced by the interviewee and interpreted by the researcher. These comments were themed and are visually expressed in the mind map, Fig. 1. Three representative comments were chosen for each theme and are depicted on the smaller branches which lead to the themes comprising the emergent and the coalescent stages of the social movement. The lighter lines depict the links between the emergent theme and the coalescent theme, that is, where there was a flow on from one stage to another as revealed in the interviews.

Prime motivating themes in the emergent stage

The prime motivator themes revealed in the emergent stage are the core internal emotions that trigger the initial stirrings, the themes that unite or lead the decision making towards biophilic design. It may be what initially motivates an individual on a course of action before the awareness of a greater social movement. The motivating themes are set out below in no particular order as they were not found to be any hierarchy of significance.

Connection to nature

Beginning with the initial group who discussed the biophilia hypothesis, the desire to increase the human connection to nature in cities has been evident as a prime emergent motivator. This tends to be coupled with a recognition of the profound disconnect to nature that is currently the dominant design paradigm of cities. Interviewees recognized that this lack of opportunity to connect with nature is an historically recent phenomenon which is impacting on the health and wellbeing of urban children, contributing to the obesity crisis. The 'free range' child is disappearing and possibly, alongside this, great environmentalists whose childhood involved significant contact with nature.

Other interviewees expressed a desire to increase people's connection to nature that was also driven by the hope of increasing local inhabitants' connection to place
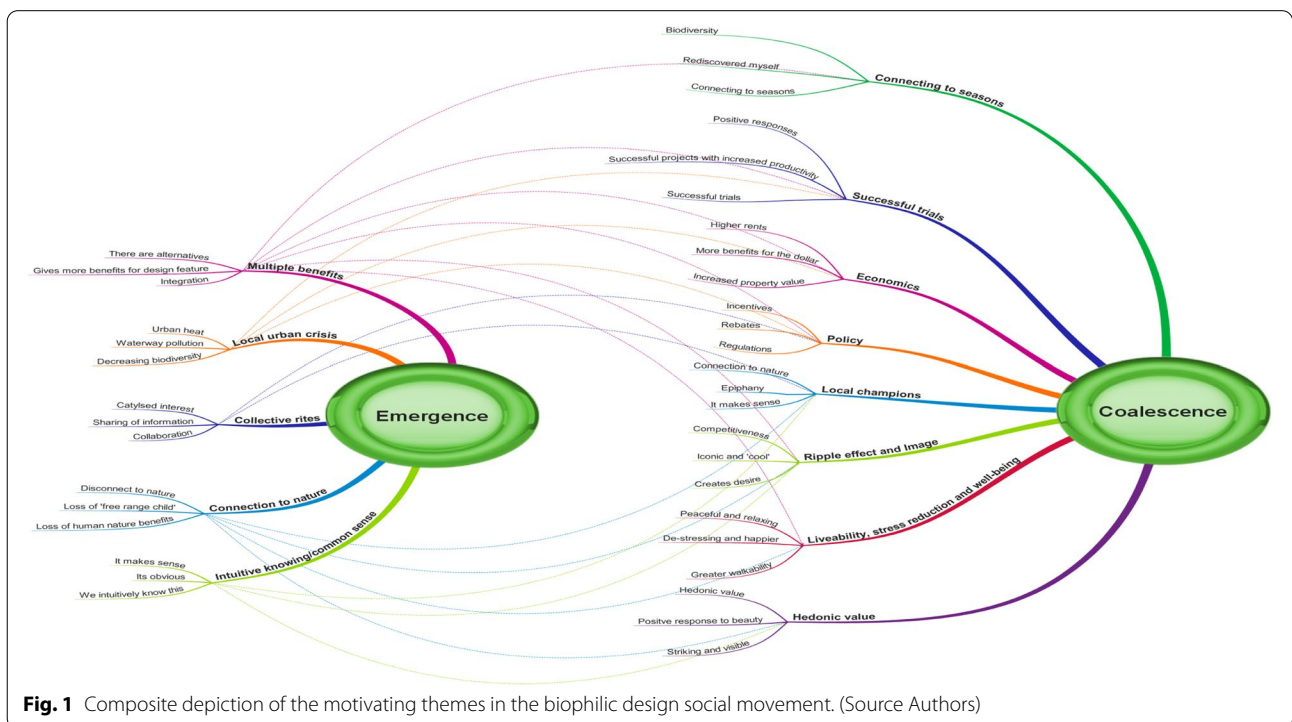

Fig. 1 Composite depiction of the motivating themes in the biophilic design social movement. (Source Authors)

and thus their stewardship of the area and the flora and fauna.

Intuitive knowing/common sense

A large number of the interviewees expressed the view that biophilic design was 'common sense' or it 'made sense'. This was particularly apparent when the interviewee had investigated design options that fulfilled their criteria and became aware of a biophilic option. Other interviewees framed this differently, on a deeper level. This understanding appeared to be what motivated them more on an emotional level than intellectual. They mentioned that it was intuitively obvious or there was an intuitive knowing. This is indicative of an inner resonance for some people with the concept of biophilic design as one would expect when it is seen as an outcome of our biological make-up as human beings. Kelliann Whitley in Washington DC who had fought to get a green roof on the building she worked in expressed it well:

> *"Ten years later and I am still really in love with the roof. When I leave the office, I sit by the roof and look and feel in a different world. Like I am in heaven. Habitat and beauty on top of an ugly building, once you learn about it, it is addictive. People want to see a living thing on top of a building. And all it does for the environment is positive. Mentally and physically it is healthy, peaceful and unique. Really it is a no-brainer."*

Local urban crisis

A local urban crisis is perceived by some and not others so can be called an internal motivator that drives change. The crisis triggers a response. The need to address a local urban crisis has been a major motivator especially in the government arena. Many of the North American cities have water pollution crises created by the CSS (Combined Sewer System) water management system, or from large amounts of storm water run-off from impervious urban surfaces. With the US Federal government mandating the necessity of dealing with this issue, as well as concern from communities, many biophilic initiatives such as green roofs and rain gardens have emerged as a result.

Urban heat featured as the other main local urban crisis which has driven a biophilic design response. This initially occurred in Chicago in response to heat related deaths, but also featured in other cities, such as San Francisco, which have awareness of heat issues even if there have not been significant deaths as in Chicago heat waves.

Less drastic crises, but still significant that were also perceived by the interviewees, are decreasing biodiversity, climate change and sea level rise. San Francisco, a city with less rainfall than the other visited cities, is primarily focused on these concerns. Poor air quality, especially indoors, has prompted technological innovations in Toronto. For Portland (and similarly Seattle) it is management of water pollution and river degradation which was threatening their salmon industry, combined with the need for increasing density due to their urban growth boundary. There was recognition by many of the interviewees that biophilic design can contribute to doing density better and retaining a place for nature within the built environment. In the ten US cities visited, biophilic initiatives in response to an environmental crisis were a strong and predominant motivator which also enabled the necessary supporting framework such as research and policy to be enacted with some speed.

Multiple benefits

Amongst the interviewees, there was recognition that there were alternatives to biophilic initiatives in achieving similar outcomes particularly in response to an urban crisis. Awareness of the multiple benefits that can come with biophilic design had frequently been a deciding factor in pursuing the appropriate biophilic design element. Of note though, is that the awareness is siloed within the sustainability arena where the interviewee and the prime motivator sit. For example, when implementing green roofs for storm water management there was awareness of the multiple benefits of potential energy consumption reduction, reduction in urban heat and increased biodiversity but little discussion of the possible social and economic benefits. Likewise, if an interviewee's area and interest was in the social benefits of biophilic design, there was a tendency to focus on the multiple social benefits and not so much the environmental or economic. Judith heerwagen in Seattle commented:

> *"It is not driven by biophilia but I think people say that if we need to do this, can we do it in a way that is not ugly? That actually adds something nice to the city. Using a swale rather than a concrete surface. Any time you can gain multiple benefits with one approach, I think you have really gained a lot. Biophilia can be used to enhance the attractiveness of features that otherwise would be very ugly.*

Collective rites

The emergence of biophilic design involved two conferences, or meetings, where first biophilia was discussed and, second, the biophilia hypothesis was discussed. Without these, the social movement of biophilic design may not have emerged. These collective rites of bringing like thinkers together are essential both in driving

the movement and in motivating the people who attend them.

The sharing of information through a collective rite such as a conference or workshop has enabled a city and its inhabitants to have the confidence to proceed in the implementation of green roofs in their city.

Conferences and workshops that provide collective rites enable the opportunity and space for the arenas of civic society, government, industry and academia to come together. This is an important space as from these collaborative meetings, direct action and implementation of biophilic design may occur.

The prime motivating themes discussed above are depicted in Fig. 2 below.

Prime drivers for change in the coalescent stage
Local champions
Throughout the interviews, the realization grew stronger that many of the interviewees were leaders and local heroes in their field. They trialed new techniques, sometimes at home, and were innovative in their ideas. At times they had to stand strong against resistance from industry, government or even community. Some of these local heroes were wise elders who, with the experience and wisdom of their years, had a deep understanding of the benefits that nature and biophilia could bring into people's lives. They had experienced it and witnessed it. They were great leaders who had sometimes extended beyond their boundaries with the knowledge and beliefs that were a lifetime's accumulation. Each city visited seemed to have its champions, those who had the vision and strength to pursue their belief. This ranged through the arenas of academia, civic life, industry and government and was a strong common element. Many of the

Fig. 2 Prime motivating themes in the emergent stage. (Source Authors)

cities appear to have owed their biophilic initiatives to the passion and belief of just one or more local inhabitants.

Some of the interviewees knew each other and referred to the other as a hero or 'local champion'. Tom Lipton in Portland was frequently mentioned and recounts his thoughts and experiences on this:

> *"It seems like that is a phenomenon of human species and perhaps there are more people in that category in Portland than other places as it relates to the idea of the environment. I don't consider myself a champion. I just consider myself as a guy who saw something and then brought it forward. But maybe a champion is someone who if they get ridiculed and you get pushed around and you keep talking then you are definitely striving towards something that others are trying to put down. People used to laugh at me. They would think I was just a whacko guy when I talked about eco-roofs. This one guy said to me recently; 'You know, Tom, I used to think you were a nut but now I see you were probably right.'"*

Most of the interviewees could be classed as 'local champions'. The influence, and necessity, of local champions was dramatized repeatedly in the interviews and people's stories, especially in establishing a program or, as set here, a coalescence of the social movement into something tangibly demonstrated.

Successful trials
Most cities seek demonstrations before proceeding further with any new idea. The progression to implementation of biophilic initiatives would not have happened if the early trials were not successful. This was repeated throughout the cities. The success of the green roof trial on Chicago City Hall gave a precedent and ability to ask the same of the developers. The high level of successful research in Toronto has made the city a leader in green roof innovations. While most of the measured outcomes have been in the environmental area, successful social and economic outcomes are also major drivers for biophilic design. Both Chicago and Portland had stories of developers who had experienced unexpected economic benefits through installing a green roof and attracting higher rents and keen tenants.

Multiple benefits
Multiple benefits are both an emergent driver and a coalescent driver. The difference is that as a coalescent driver it is more about the discovered benefits after installation. Many of the related stories, particularly around green roof implementation, were about how they were initially constructed for environmental
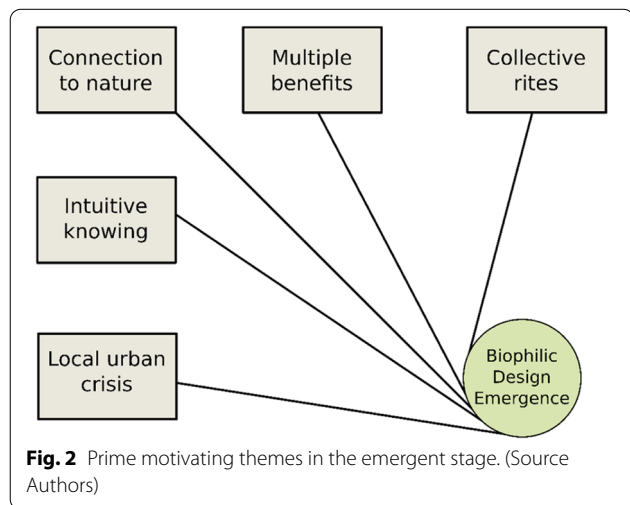
outcomes. Other benefits, the social, economic and unplanned environmental, were 'discovered' after the installation.

Observation and experience of the biophilic design initiative, as related by the interviewees, consistently revealed further benefits beyond the initial targeted benefit. This translates to a greater understanding of all the environmental, economic and social benefits that are associated with biophilic design elements. A significant number of interviewees commented on the exposure of the multiple benefits inspiring them further.

Strategic policy

The success of trials, particularly with green roofs, was a vital stepping stone towards enabling the introduction of strategic policy in some cities. In Chicago the trial occurred within the government arena with a successful green roof on City Hall. This alone was not enough to progress the adoption of green roof initiatives by developers which is why strategic policies were created to progress green roofs in Chicago. Green roof standards were included in Chicago's sustainable development policy. After initial resistance, developers discovered they enjoyed positive responses and further benefits from clientele. City of Chicago's own research, as related by the city planner below, revealed that 82% of green roofs in Chicago were installed because of policy.

> *"Were they built because of the policy? Were they built because it was voluntary? Was it because of the storm water ordinance? Or was it because of our green permitting program? What we found out was that 82% of those roofs were due to the sustainable development policy. So that has been our main driver. We are assuming that many of our LEED buildings are because of the policies as well. We have found that regulation has been more effective than incentive. The stick rather than the carrot."*

In Portland, Oregon, legislation promoted the use of green roofs in response to the Federal *Clean Water Act.* This was after successful trials by local champions who took their successful outcomes to a receptive member of government. It was a similar story in Toronto.

Biophilic design suitably sits under the umbrella of a variety of policies. By adopting a general strategic policy statement, for example simply joining or aligning with the goals of the global Biophilic City Network, cities can begin to work towards encouraging increased uptake of biophilic design initiatives. It is often easier politically to begin with a strategic policy statement than a regulation requiring every development to include biophilic design elements.

Ripple effect and image

A consistent observation from interviewees was the experience of the ripple effect. This is where observation of a feature leads to the observer wanting one also and acting on this desire. Demand for biophilic initiatives can be driven by the consumer base who, by witnessing examples, request similar from developers. It can ripple through the design and construction industry if it is seen to give a competitive advantage by this increased demand. This is how a market demand is started for biophilic urbanism in this coalescent stage though all the other factors combine to provide its on-going market demand and eventually to be a more mainstream phenomenon.

Aesthetics

People respond to beauty. There is a proposition in the research literature that human responses to aesthetics are prompted by evolutionary survival instincts and are a component of innate biophilic tendencies [9, 13]. The academic literature has shown that humans have positive psychological responses to aesthetics and the varied textures, patterns and motions of nature contribute to people's appreciation of beauty. There are often alternatives to biophilic design that are less attractive. People choose the biophilic approach as it contributes to the aesthetics of an area, so it brings another benefit beyond the function. Building design based solely on function and technology to meet sustainability standards such as energy efficiency may not be attractive for people which may make it less politically acceptable. The aesthetics of biophilic design addresses the human factor of sustainable design.

People are willing to pay for views of nature, which demonstrates that there is a hedonic value attributed to an aesthetically pleasing building to live or work in. Value is also obtained by good landscape architecture which is a well-established profession and practice, typically brought in at the end of a building project to 'beautify' the landscape. Biophilic urbanism would suggest that designers need to consider natural features in the building fabric and in its surroundings from the earliest stages of a development otherwise the deeper aesthetics are lost as token plantings are made. Developers, according to the interviewees in each town, are becoming more interested in creating a stronger link between their developments and biophilic design because people seem to respond to it.

Economics

The economic case for biophilic design did not initially drive the first demonstrations in the cities under

study. The first steps were seen to be an extra cost but after a while this seems to have merged into a much broader acceptance that the economics of biophilic design was manageable and that other benefits included potential to be an economic success story due to the increased value it created. Owners and developers of buildings which incorporate biophilic design elements were found to have discovered economic rewards particularly through higher rents and increased property value. In commercial buildings biophilic design led to retail sales increasing and hospitals enjoying the economic benefits of shorter hospital stays and less stress amongst patients and visitors, especially in waiting rooms. Most interviewees had stories of demonstrations of sometimes unexpected economic benefits which had inspired further biophilic design projects. An increasing recognition of the multiple benefits that result from biophilic design emerging was that many interviewees suggested there was growing recognition that there is good return for the money spent.

Liveability, stress reduction and well-being

Some of the interviewees had personally discovered how access to a green roof was relaxing and peaceful and contributed to their well-being. Other interviewees related stories of observed behavior and anecdotes which demonstrated people's responses and appreciation of increased access to nature in the urban environment,

The many qualities of biophilic design contribute to increased wellbeing and liveable cities. Engaging people with nature through gardens or shaded streets has been well known for many years to increase the walkability of a city and the health of its inhabitants. The addition of biophilic design to the buildings and infrastructure was seen to increase this factor even more. Stress reduction and happier, healthier people were frequently mentioned outcomes which inspired further design initiatives.

The eight prime motivating themes in the coalescent social movement stage of biophilic design are illustrated in Fig. 3 below.

Mainstreaming actions for implementation

The biophilic design social movement was largely at the coalescent stage when the interviews were collected. Few people suggested that it was mainstream yet, though many felt it could become so eventually. Derived from the immersive journey, the interviews and the composite depiction set out above, the components of mainstreaming the biophilic design social movement can be formulated.

Fig. 3 Prime motivating themes in the coalescent stage. (Source Authors)
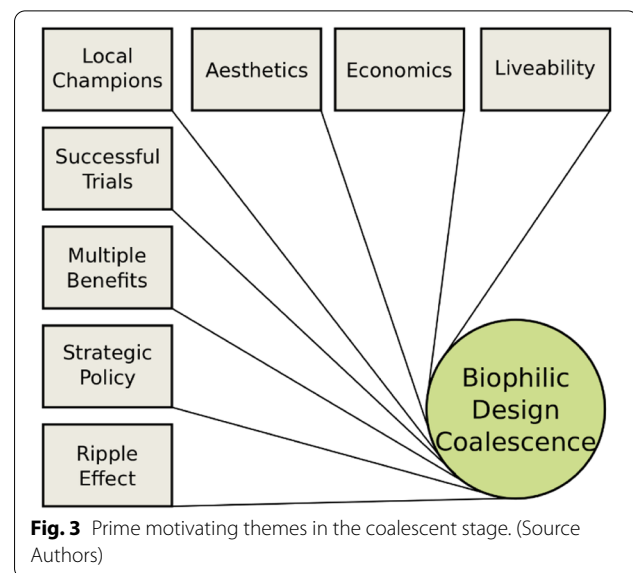
Identify the need

Where there were clear urban crises which biophilic design could assist in mitigating, the interviewees suggested there was still much to do on research, trials, and further policy development before such solutions could be mainstreamed. The interviewees felt that not many urban crises are unique to a city, rather they are mostly shared globally but may vary in their intensity. Each city therefore needs to identify their driving issues as a unifying starting point but mainstreaming was probably fairly similar.

A city inventory or 'stocktake' would assist in helping to identify the current state of the city. Surveys of the urban environmental condition which include biodiversity quality and risk factors of climate stress such as urban heat and flooding could be undertaken. A social inventory of people's health and wellbeing plus their access to nature and daily interactions would also provide base indicators from which policy makers, city planners and designers could plan strategies towards a healthy, biophilic city. This assessment may also help provide the motivation and rationale for biophilic initiatives.

Identify and address barriers

Many of the barriers to biophilic design which are found in a city are not unique to that city but have been encountered and overcome in the pioneer or forerunner cities of biophilic design. They are often set out in the biophilic design foundation literature by Kellert and Beatley in the referenced literature. Common barriers which this research journey identified are outlined

below and, as can be seen, are not unique to biophilic design but can have global relevance to many environmental issues.

- Higher initial costs
- Ongoing maintenance costs
- Siloed benefits
- Lack of understanding
- Lack of precedent
- Fear of new technologies and associated risks
- High water use
- Lack of leadership
- Lack of political will
- Financial mechanisms not reflecting the benefits, especially in health.

Some barriers are perceived and tend to arise from lack of understanding and knowledge and so can be addressed by education and learning from other cities' experience. This is where conferences, workshops and joining global organisations, such as the Biophilic Cities Network, can be useful.

Most of the interviewees felt that by following this framework of identifying needs and barriers to the mainstreaming of biophilic design, gives hope that these barriers could be overcome.

Unite silos through collaboration

Siloes and separation between professions appears to be common within societal structures globally on many sustainability issues. Biophilic design is felt by all the participants in this research to be highly inter-disciplinary, combining design professions, academics, engineers, developers, planners, health professionals and others. Facilitating interdisciplinary, collaborative communication on biophilic design data and research was considered to be essential to help streamline implementation, increase efficiency, lead to further innovations and improve biophilic responses to urban issues.

Collaboration was also seen to be essential across government, industry and community. Conferences and symposia provide the opportunity to bring together these disciplines and stakeholders. Collaborative meetings such as these are seen to address the barriers of siloing and expose the potential for interdisciplinary multiple social, environmental and economic benefits. Being aware of the inter-disciplinary nature of biophilic design and the multiple benefits that can ensue through implementation also was seen to provide the groundwork for financial contributions from stakeholders. An example given was the environmental benefit of cooling cities through direct nature and greenery. This reduces urban heat and heat related health stresses and deaths (such as the previously

discussed Chicago response). Health costs for treating heat related issues would therefore diminish. 'Should Health Departments then contribute towards greening cities?' was a question suggested to be discussed by those cities seeking to mainstream biophilic design. Such interventions were seen to contribute towards development of best practices in biophilic design, synergistic benefits and the opportunity to involve, support and further educate self-organising efforts from civil society and thus build social capital from rebuilding the natural capital of cities.

Enable local champions

From these collaborative gatherings, or driven by a personal interest and understanding, the potential for the emergence of local champions exists. These are the people to whom the wholistic framework makes sense and who are prepared to step up and out and push through any barriers and lead to mainstreaming. The way they do this was considered by interviewees to usually happen through telling stories.

The importance and power of stories was often mentioned by the interviewees and many told a story to demonstrate a concept and an outcome in a powerful manner. People relate to these and in an emerging movement such as biophilic design, stories can reach many people in different arenas, beyond the academics and professionals. They are easily understood, providing real life examples and proof. Stories can connect people to nature more, encouraging them towards greater stewardship of their environment and beyond. They can teach things about nature in a way with which people can identify. Many of these stories have found their way into books (eg [2, 17, 19, 23]).

The collected stories from interviewees in the research journey, especially the local champions, revealed more information and increased understanding beyond academic research. The stories revealed the motivators of either the city under discussion or the personal motivations of the local heroes. They also illustrated both social movement theory and biophilic concepts. Beyond that though, the stories helped to characterize the collective identity of the biophilic design social movement.

Create partnerships

The stories collected throughout the research journey are stories of pioneers and innovators in biophilic design mostly working alone to begin with but creating partnerships in the process. Many formed small groups in order to get underway. Once they had a sense of being in possession of a solution all of the key players found partnerships where they could begin delivering the practical outcomes. Thus most of the interviewees considered this process could continue into the mainstreaming phase.

Many of the other factors considered necessary for mainstreaming, like fostering collaboration and inspiring local champions, will potentially lead to the creation of partnerships that can deliver biophilic design to the market place. The challenge will be for governments at all levels to foster these collaborative partnerships, particularly between industry, investors and researchers, and recognize the importance of supporting emerging industries and new technologies. These partnerships can support each other by creating or improving the culture for innovative thinking thus barriers can be removed, investment increased, and the market for innovation enhanced and diversified.

Set up demonstrations

Collaboration, local champions and partnerships supported by, and including government, were all considered to enable more, and better, case studies and demonstrations. The benefits of these initial implementations of biophilic design principles are multiple:

- They provide the meeting place for the different players and arenas.
- They provide the precedence and can break through barriers and rationalize risks.
- They offer the opportunity for research, data collection and innovation.
- Implementation of biophilic design elements can lead to post-completion understanding of the full range of benefits through experience and observation.
- Observation of the initiative could stimulate market demand.

The Chicago City Hall green roof was considered iconic by the participants. Its importance is due to its early implementation as one of the first major green roofs in North America, as well as the fact it was installed as a case study and demonstration. It was designed to study thermal properties, plant survival rates, storm water retention and, importantly, to educate. The roof was successful in all its goals and green roofs proceeded to be implemented throughout Chicago. It established a precedent. The Chicago City planner could show developers who were reluctant to comply with policy how it was done and how it looked. Demonstrations and case studies are thus seen as vital in providing the tangible showpiece and knowledge to motivate further implementation.

Demonstrations are important in social movement as they are not only important in setting precedents and providing knowledge, they also provide a visual example which can trigger the ripple effect of implementation [11]. Some developers, investors and clients such as the Washington DC embassies, have green features installed as they enjoy being an early adopter, seeing an opportunity to be unique and iconic. For others, it may be the observed social amenity and aesthetics that motivate them to install their own. Bartczak, Dunbar and Bohren's [1] research into people's decision making processes towards installing a living green wall concluded that the wall's contribution to building aesthetics was the most important factor in the process. This, possibly hedonic, value of green infrastructure contributes to the ripple effect of copycat installations that can follow from the initial demonstration.

Integrate into professions

The research journey reinforced in every city what the literature had already revealed: a lack of integration among the professions as outlined above in the need for partnerships. This is not unexpected as biophilic design is still not a mainstream educational opportunity nor are there professional organizations that have set up to provide the integrated science, psychology and design elements of biophilic design. The professionals interviewed had largely developed their expertise through their own experience and through demonstration projects. Mainstreaming was seen to need new educational programs and new professional bodies to be formed. Biophilic design will then be mainstreamed when it is integrated into urban design, landscape architecture and architecture as an everyday practice and not seen as an add-on. The first stages will require academics from backgrounds in environmental science, engineering, urban planning and policy, humanistic psychology and design at all scales, to form integrated teaching programs that can bring out the core principles and practices of biophilic design. When mainstreamed, biophilic design will be a standard part of education and will be prolific throughout the literature.

Professional practice, as seen by all the participants in the research, will need to be modified through demonstrations that can help to rewrite the manuals of built environment practice. This will be a process of trial and error with rapid learning that is passed on throughout the growing social movement across the globe.

Create delivery structures

The interviewees listed a series of practical delivery structures they considered as necessary for the mainstreaming process.

Conferences

Conferences are a particular practice of society that has powerful delivery outcomes. People who come probably already share a common identity, however loosely, but at conferences, stories can be shared and exchanged, themes can be explored and unified plans made.

Face-to-face conferences provide a forum for the aligning of frames and recognition of the common identity. In five of the cities visited, conferences had been held which had an impact on the progression of biophilic design. They brought together players from different arenas with a common problem needing to be solved. These conferences can also provide the framework and education to foster local champions.

Collective rites at a conference can bring together people who otherwise may not meet. They may be from very separate arenas yet have a common goal, or common problem to address. Uniting these groups through collective rites is essential for establishing a functional wholistic framework for urban design. Indeed, the initial group whom Kellert brought together were from diverse backgrounds, yet as one interviewed attendee mentioned, they focused on creating more pleasing, happier and healthier cities, with the diversity adding to the richness of the outcome.

Government regulations

Policy has been successful, particularly in the implementation of green roofs in global cities, by incorporating the option for a green roof in sustainability standards, or by providing incentives and rebates, and by regulation.

Chicago successfully implemented policy which led to a substantial increase in the number of green roofs in the city. Chicago City found that regulations, the stick, worked better than incentives, the carrot. But there was a difficult time of initial implementation due to a backlash from developers and planners which needed the mayor and the city planner to stand firm.

Globally, there is a growing tool kit of options for policy.

Civil society presence

Civil society drives much change as without it governments are rarely able to achieve the political ability to make changes that stick. Thus activism that can create a strong presence with media and generate strong community support is a critical step in each phase of a social movement, especially mainstreaming [6].

Government recognition of community impetus in biophilic activism is crucial for enabling policies that support the community and any positive self-organising initiatives in the community and business.

Industry and business interest

Industry is also critical as government cannot act without some industry interest and the community cannot do the actual projects, they must have industry interested enough to try out the ideas. Thus leaders in industry need to be found who are prepared to set up good

demonstrations and with the support of leaders in the community and leaders in government, a mainstream process can begin to be established.

Make the business case

In the interviews the strongest barrier to the implementation of biophilic design in cities was the upfront costs. Even where the costs were comparable but different design thinking was needed, interviewees expressed an encountered resistance to varying from business as usual.

Presenting research, perhaps through a conference, outlining the social and environmental benefits and how these translate to economic benefits, would help to provide the business case for both government and industry investors. Detailing technical know-how and product information would assist to alleviate the perceived risks associated with the lack of knowledge and understanding. If the multiple social, environmental and economic benefits were understood in all arenas, it would assist in uniting the arenas towards a combined integrated approach. This would hopefully provide greater means and funding for biophilic design implementation.

In addition, while a complete cost-benefit analysis which includes financial assessment of the multiple benefits would be challenging in its scope, much research could be done within defined parameters that presents a solid business case [4]. For example, life cycle analysis could strengthen the case for green roof implementation by factoring in the savings from the extended roof life, reduced energy consumption and water management plus increased biodiversity and the health and social amenity benefits. Comparative life cycle costing of non-biophilic alternatives may also strengthen the case for biophilic options.

Ideally, to shift away from economic analysis of single projects would be the most beneficial. If, for example, a green roof was installed solely for the economic savings in storm water flooding prevention and did not deliver the expected financial outcome from the individual project, then further green roof projects could be stalled. Obviously storm water reductions are likely to be economic when sufficient buildings in an area are all displaying biophilic characteristics. The same can be said for reducing heat island effect and health improvements from biophilic design.

Viewing a city as a functioning natural system where the benefits of biophilic design were understood to address a variety of the city's issues would strengthen the business case by removing the emphasis on simplistic, single building economics as the sole criteria. The human economy depends on the natural economy: on biodiversity and functioning eco-systems which are best seen when a whole city or major corridor are able

to demonstrate the integrated and multiple benefits of biophilic design. This interdependence needs to be factored into policy decision making and a biophilic design business case approach can provide an interface between the two.

Link to academic research

In almost all the cases examined and the people interviewed there was a link to academic research. The social movement needs its work validated and enabled through academic interventions that not just provide the data and refereed scientific papers, but the academics involved can help support the business case and political process to get approval for projects and mainstreaming.

The divisions in academic research between professional disciplines means that biophilic design is slower to flourish. While the research benefits are there in the literature under their niche headings, their lack of integration necessitates an interpreter: someone who will do the exploratory research into the literature and champion the cause. The next phase of mainstreaming will need more integrative research and the people involved in the social movement will need to seek out links to academic research in their cities if they are not already there.

The framework of actions for mainstreaming the social movement of biophilic design are diagrammatically expressed below in Fig. 4.

Conclusions

A love of life, or biophilic connection to nature in cities, is a consistent theme that has driven the social movement of biophilic design. People in cities need greater connection to nature in their daily life. The biophilic design social movement appears to have emerged and even coalesced in some of the cities studied. However, for it to mainstream, as happens in successful social movements, it will need to develop a series of components that were identified and suggested by the local champions in each city.

The research, based on interviews with these local pioneers in the biophilic design social movement, has shown a social movement with similar motivators, drivers, themes and components based on the integration of biological/environmental science, psychology and design. The interviewees told a story and created a vision of possibilities where biophilic design is an integrated component of city design. They helped define the three phases in the social movement – emergence, coalescence and mainstreaming – as set out in Fig. 5. The final stage of mainstreaming was not yet developed in any city. However, the interviewees assisted in the development of a framework to take the emergent and coalescing movement into its next phase of mainstreaming biophilic design initiatives in global cities. This framework had ten actions as shown in Fig. 5.

The social movement of biophilic design has begun a shift in the approach to the inclusion of nature within cities in new and more practical design solutions that make it part of daily life. There is little doubt that cities need
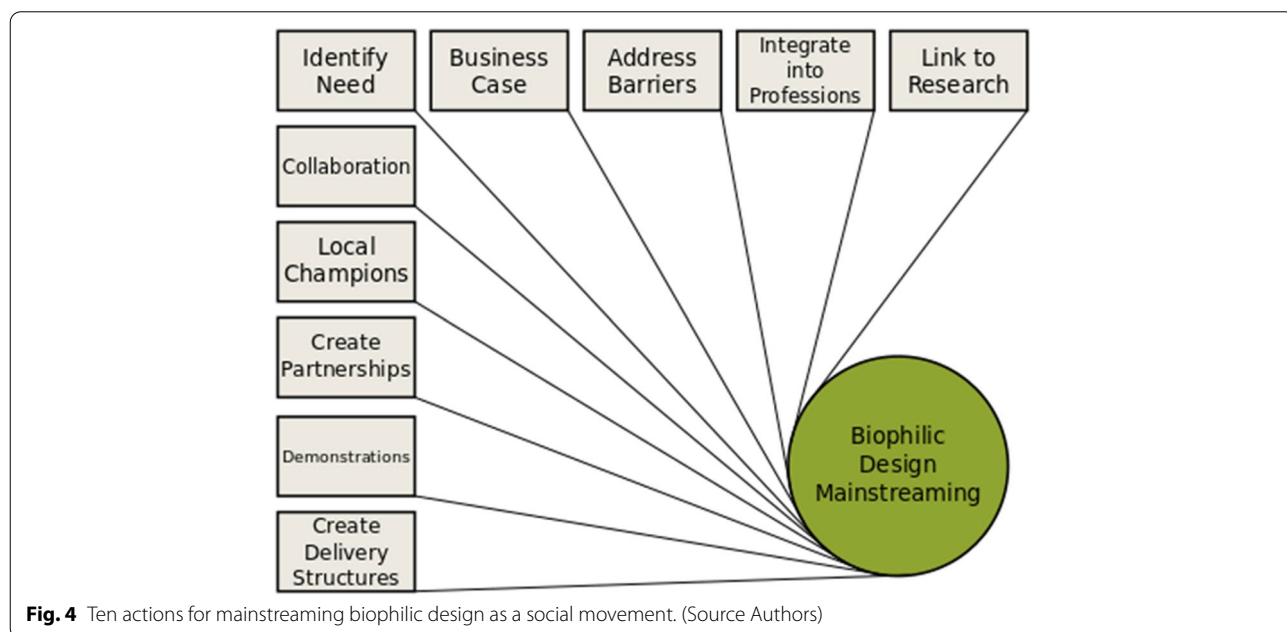

Fig. 4 Ten actions for mainstreaming biophilic design as a social movement. (Source Authors)
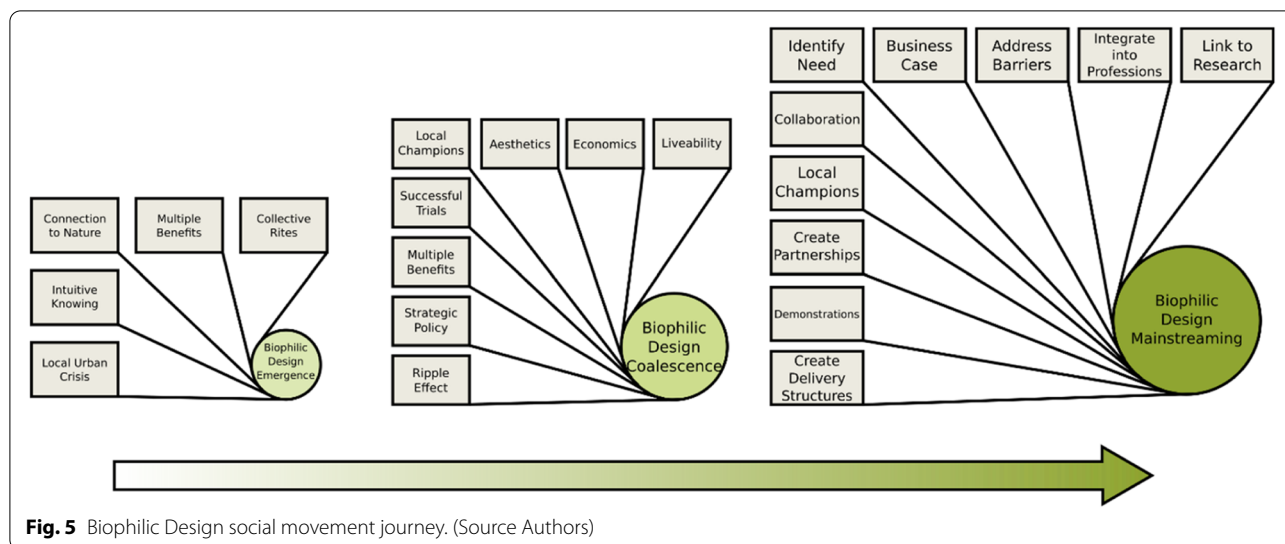
Fig. 5 Biophilic Design social movement journey. (Source Authors)

this kind of biophilic design. Perhaps cities are ready and possibly willing, to mainstream biophilic design but this research has shown it will take significantly more of the identified actions to make this happen.

Vancouver	**Randy Sharp**Principal Sharpe and Diamond Landscape Architects	**Cornelia Hahn Oberlander**Landscape Architect
AUSTRALIA		
Perth	**Mayor Brad Pettitt**Mayor of the City of Fremantle	**Julian Rose**Director Deep Green Corporation

Authors' contributions

Conceptualisation, JS; Methodology, JS, PN; Investigation, JS; Analysis JS; Original draft preparation, JS; Review & Editing JS PN, All authors read and approved the final manuscript.

Availability of data and materials

The dataset used and analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Consent for publication

Not applicable.

Competing interests

The authors declare they have no competing interests.

Author details

[1]Curtin University, Perth, Australia. [2]Biophilic Solutions, Perth, Australia.

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