

CIEEM Ireland Spring 2021 Conference

Mapping of Dublin urban green spaces (UGS) and historical land use change to determine habitat continuity

Maryann Harris^{1,2} and Tamara Hochstrasser¹

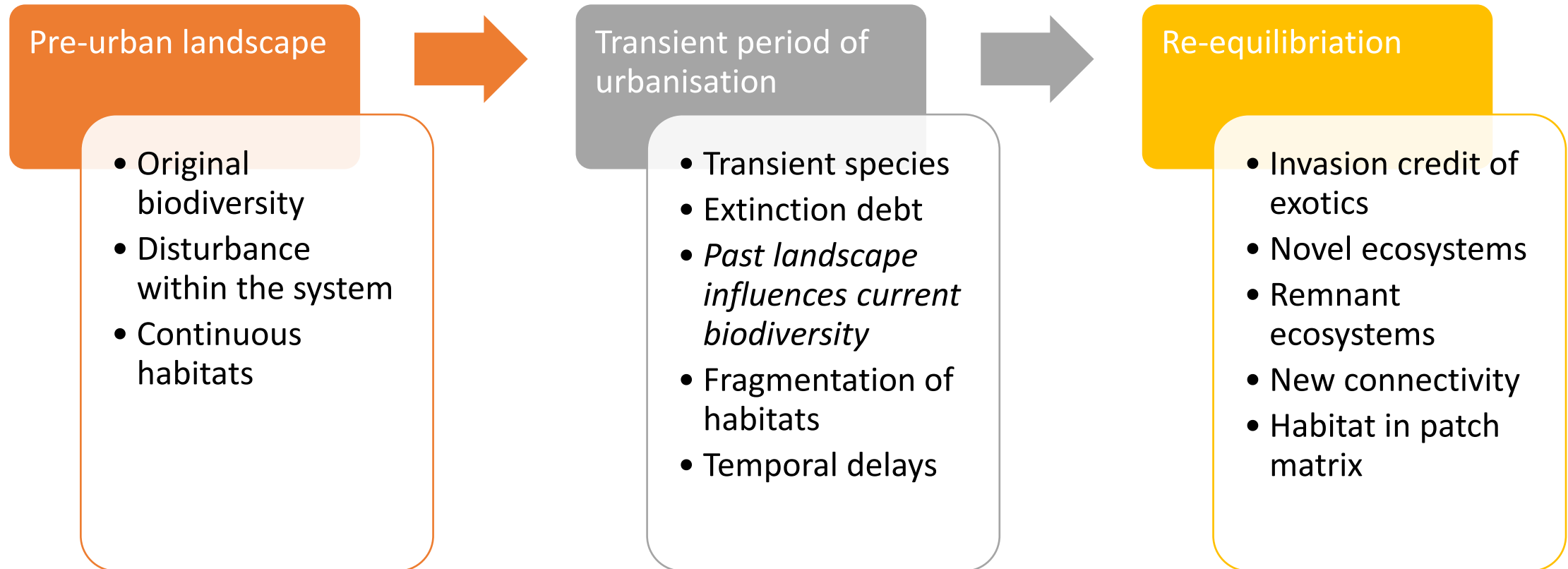
¹School of Biology and Environmental Science and Earth Institute, University College Dublin

²Dublin City Council Parks, Biodiversity and Landscape Services



Development of remnant ecosystems of cities

(based on Ramalho and Hobbs 2012)



Why does this matter?

“Conservation of urban remnant ecosystems will become increasingly important for several reasons:

1. Especially in areas with high beta-diversity, remnants provide the **only remaining habitat** for many species.
2. They **provide ecosystem services** (e.g. water infiltration, microclimatic amelioration, sequestration of air pollutants, recreation and aesthetics) that improve the urban environment and enhance the wellbeing and quality of life of urban dwellers.
3. Urban remnants are the primary **connection that many humans have to the natural world**. Preventing the extinction of this experience is important for conservation far beyond city boundaries”.

(Ramalho and Hobbs 2012)

Historical knowledge is needed to implement Nature-Based Solutions in Dublin

- Need to identify remnant habitats and populations for NBS.
- Age of UGS defines habitat continuity and can be measured to analyse factors of urban ecosystems (Onandia et al., 2019).
- So far:
- Limited systematic assessment of UGS in Dublin City at ecosystem level to direct NBS.
- Previous ecological studies have been focused mainly on habitat and species surveys of individual parks.
- Spatial analysis of UGS in Dublin has primarily focused on audits of recreational and amenity characteristics with some inclusion of policies for biodiversity in green infrastructure strategies.
- Lack of detail in maps for ecosystem services assessment and targets for restoration.

Research Objectives

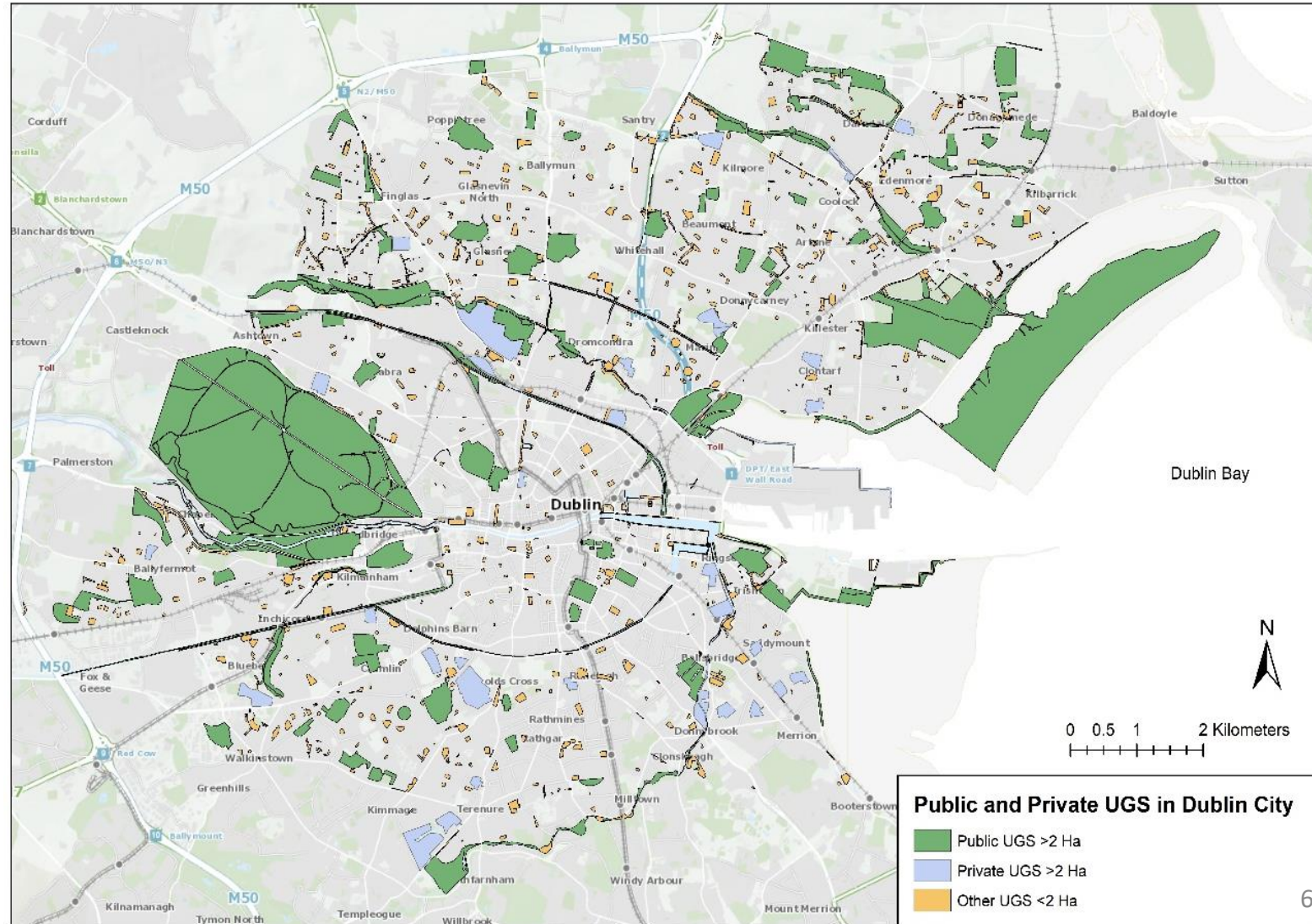
- To analyse land use history and urbanisation of the UGS in terms of impacts on biodiversity and ecosystems.
- To develop a typology of the historical land uses in public UGS to determine the continuity of habitats in those spaces.



Results - distribution and ownership of UGS

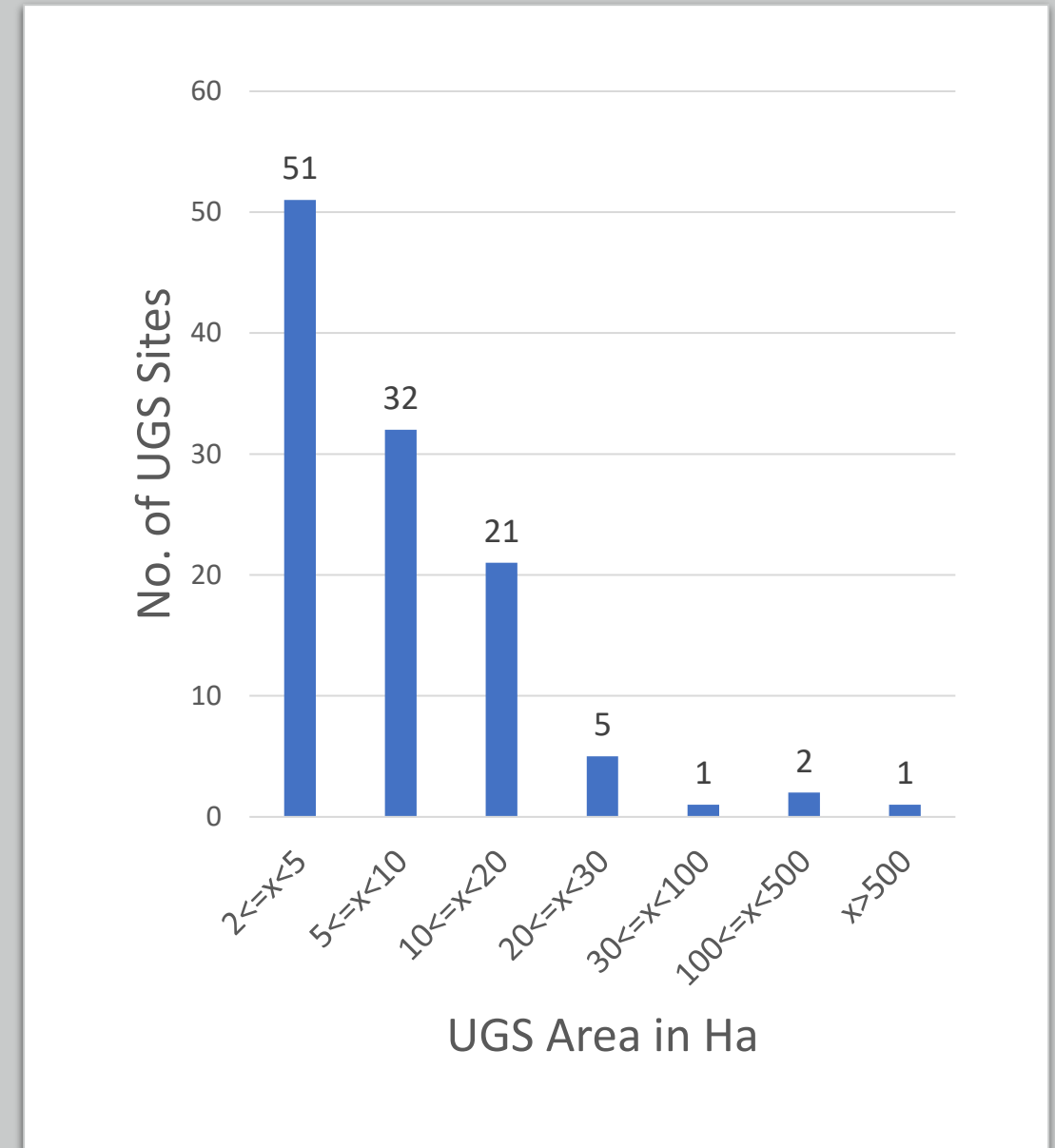
- Of 1,238 polygons mapped comprising 300 UGS, 147 polygons are ≥ 2 ha.
- 113 UGS sites were confirmed as ≥ 2 ha and in public ownership over a total area of 2,016 ha.
- Within the city centre, there are few UGS > 2 ha. Most are located north of the River Liffey.
- Fragmentation - The biggest land banks are not connected.

Base maps: Ordnance Survey Ireland (2019) and Dublin City Council (2016)



Area of UGS

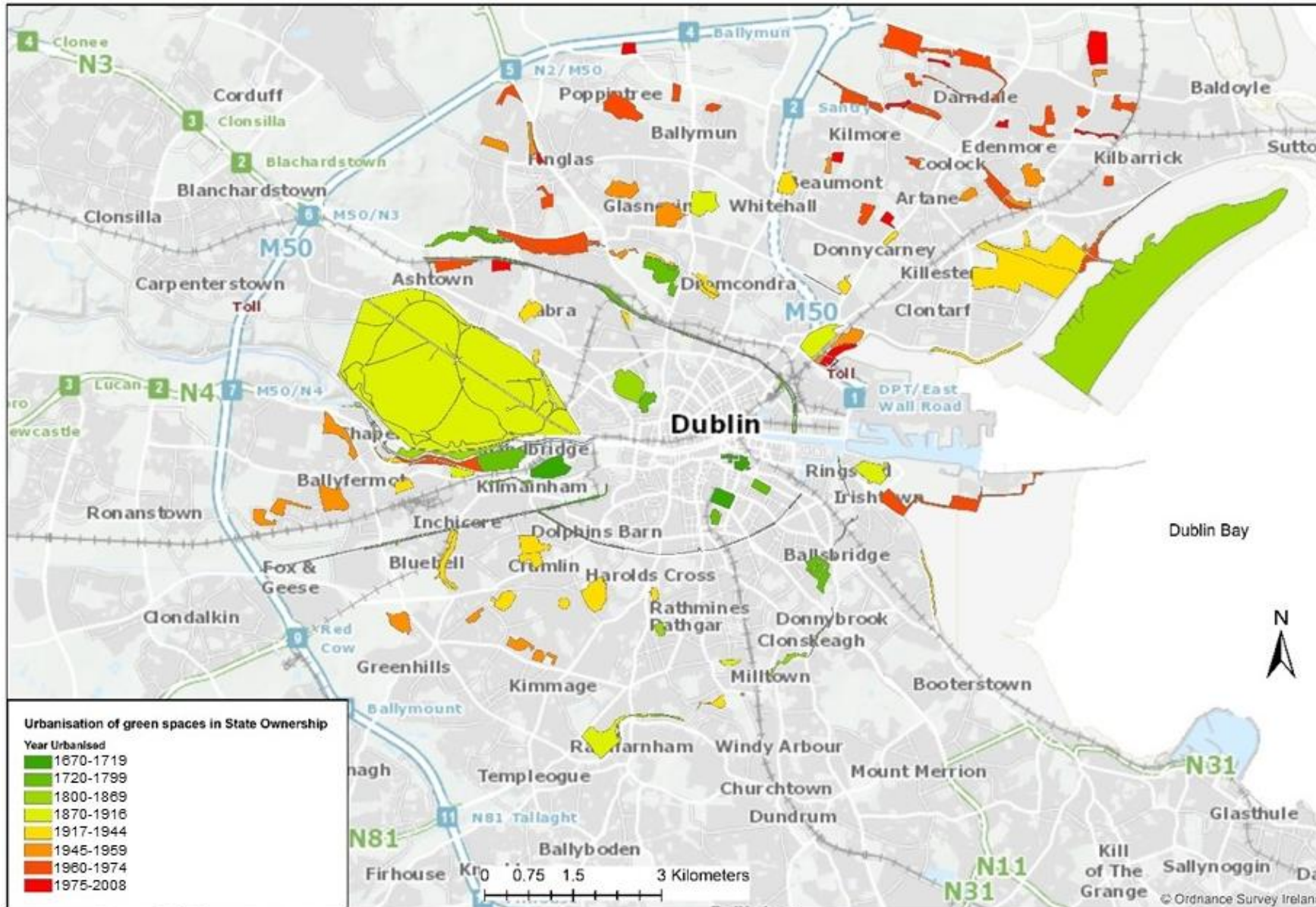
- Almost half (51/113) of all public UGS are 2-5 hectares in area with the median area calculated at 5.42 ha.
- Only four UGS > 30 hectares:
 - Phoenix Park
 - North Bull Island
 - St. Anne's Park
 - Tolka Valley Park.
- The three largest public parks (Phoenix, North Bull Island and St. Anne's) provide 58% (1,163/2,016 ha) of the public UGS >2 ha in the City.



Methods for determining urbanisation

- **Year urbanised** = UGS was **enclosed on at least two sides by built infrastructure** (roads, buildings) in line with the definition of “green urban areas” in the European Union Urban Atlas (Copernicus, 2016).
- **4 key maps** used for land use analysis (1757-1937) – Rocque, Ordnance Survey
- Maps obtained from an online viewer with OpenStreetMap (Hollinshead, 2019) which are not detailed enough for land use analysis but provide road layouts that indicate enclosure of green spaces:
 - British Geographical Section General Staff (GSGS) 3906 series map (GSGS, 1941)
 - Geographia Plan of Dublin (Irish Tourist Board, 1945)
 - Ordnance Survey of 1968 Index to O.S. 1:1000 maps (OSI, 1968)
- After 1968 OS, based on age of housing stock, records of parks (Barry, 1999) and reference to the Dublin Ordnance Survey of Ireland Geohive website (OSI, 2019) to view recent aerial photography from 1995 to present.
- Intervals of time are determined using Jenks natural breaks classification method (Jenks, 1967) in ArcMap 10.4.

Year of urbanisation of green spaces in State ownership

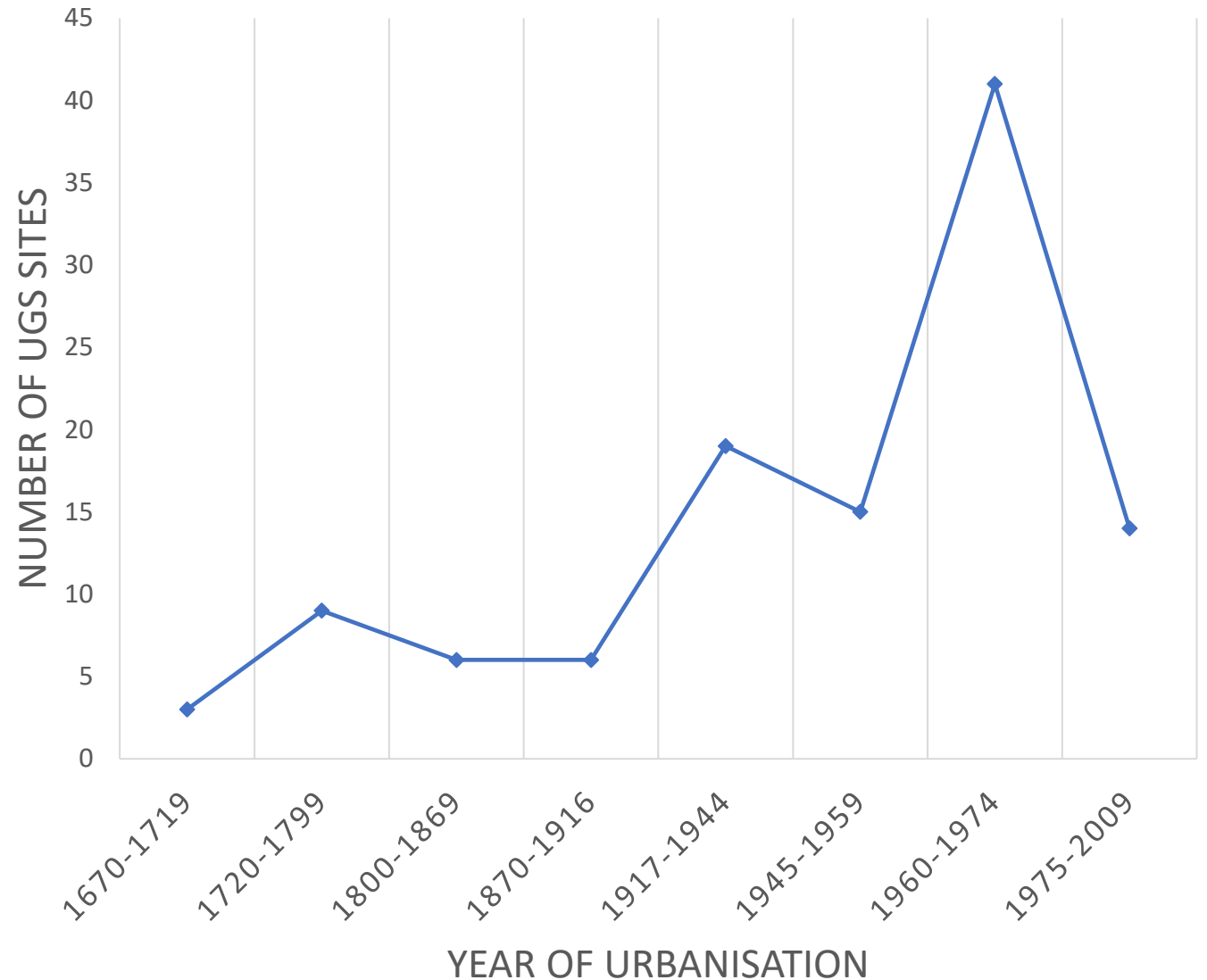


- 62% were urbanised since 1945
- Distribution is not radial
- Concentric a bit within canals and prior to 1719
- But suburbs not uniform gradient of urban-rural as in traditional ecological studies

Ordnance Survey 2019

Phases of Urbanisation

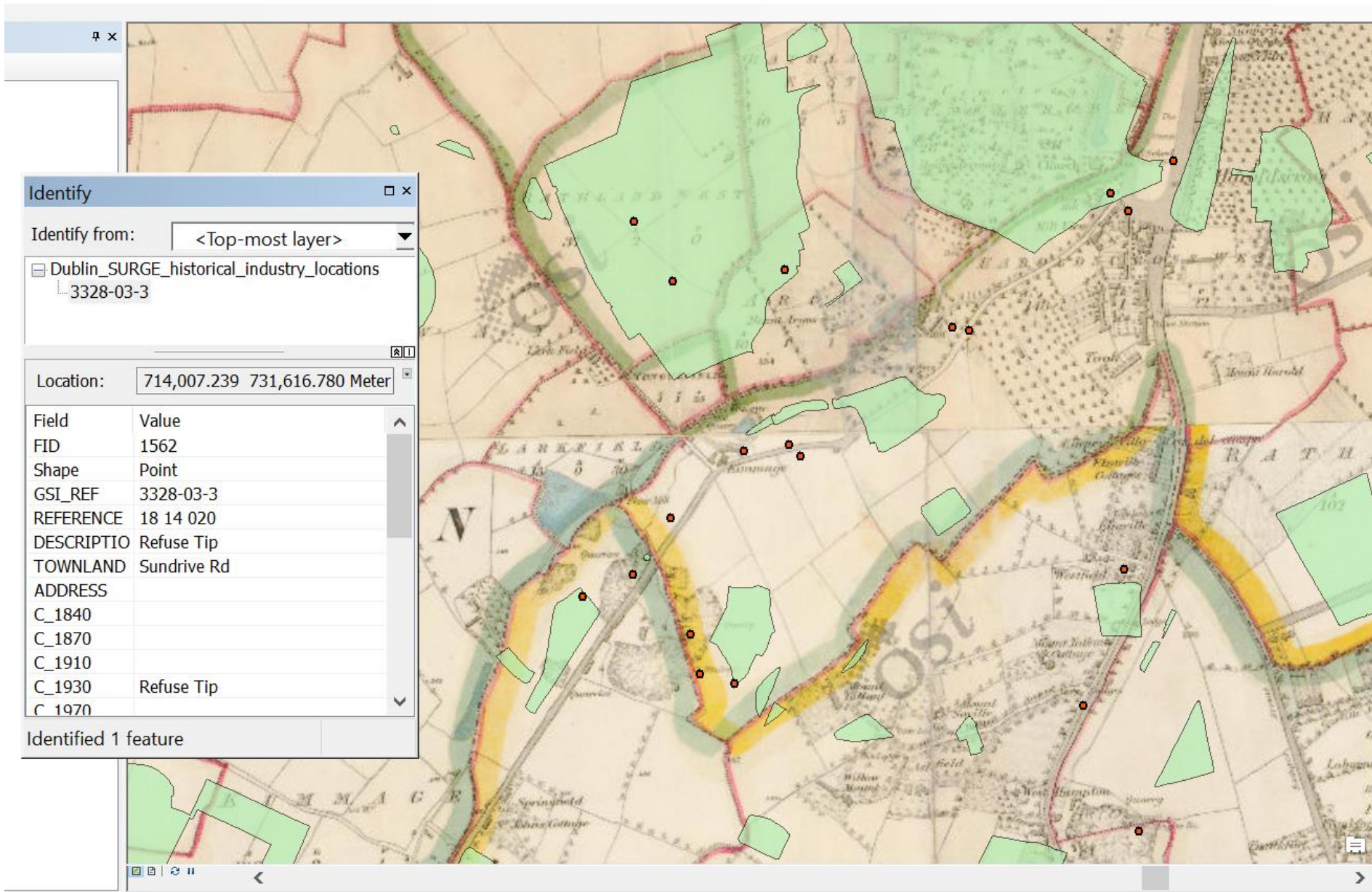
- Urbanisation of green spaces can be seen in three phases: 1720-1799, 1917-1944 and 1960-1974.
- 79% (89/113) of public UGS ≥ 2 ha in public ownership were urbanised in the past century.
- 62% (70/113) urbanised since 1945.



Categorise historical land uses of patches (public UGS)

- Four key historical maps series were used:
 1. Rocque's Maps of Dublin City and County 1757-1760
 2. Historic 6-inch colour (1837-1842) Ordnance Survey map
 3. Historic 25-inch (1897-1913) Ordnance Survey map
 4. 1937-1938 Fourth Edition Six Inch Maps of Dublin Ordnance Survey
- Verification of land uses with multiple sources:
 - Historic Industries = Geological Survey of Ireland SURGE database (Glennon et al 2012).
 - Demesnes and Ecclesiastical = National Inventory of Architectural Heritage database (DAHRRG, 2012), DCC Archives.
 - Landfills = Eastern-Midlands Region Waste Management Plan (2015 – 2021), Noone (2016), interviews, DCC records
 - Allotments = locations published by Forrest (2011, 2013, pers. comm.)
 - Woodlands = NPWS database (Perrin and Daly 2010)
 - DCC Parks and Open Spaces database (DCC 2016)
 - Historical records
 - Interviews with DCC staff, grey literature

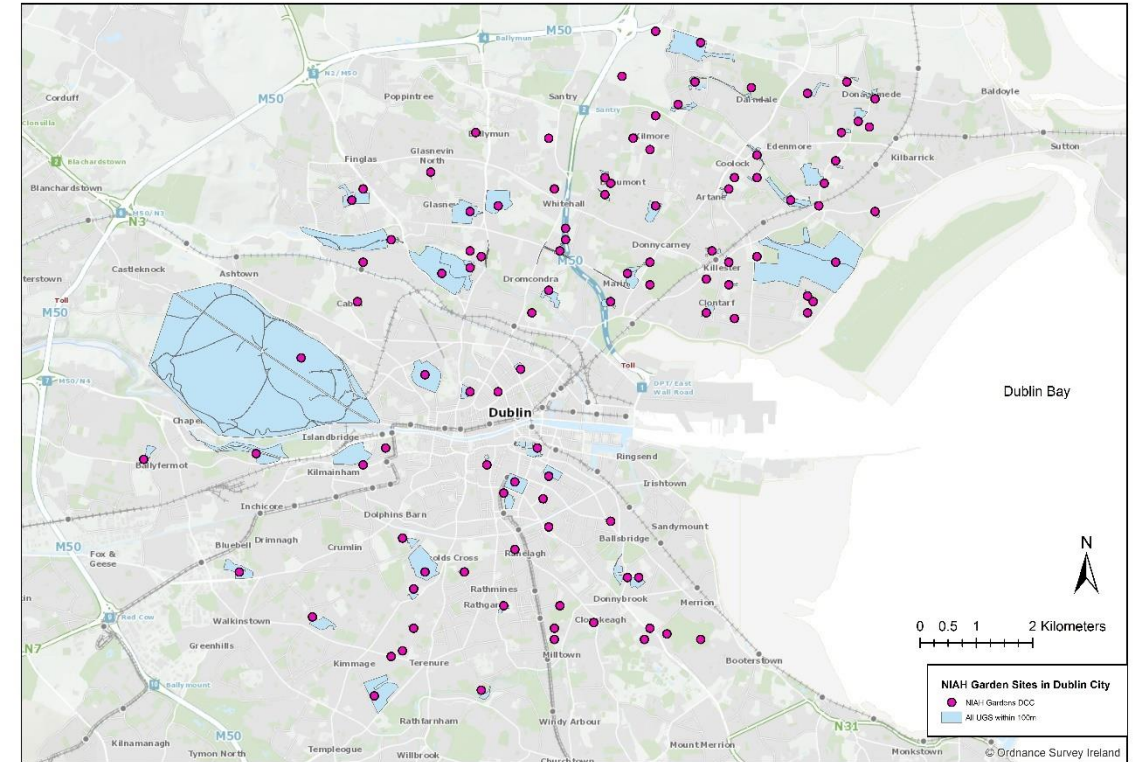
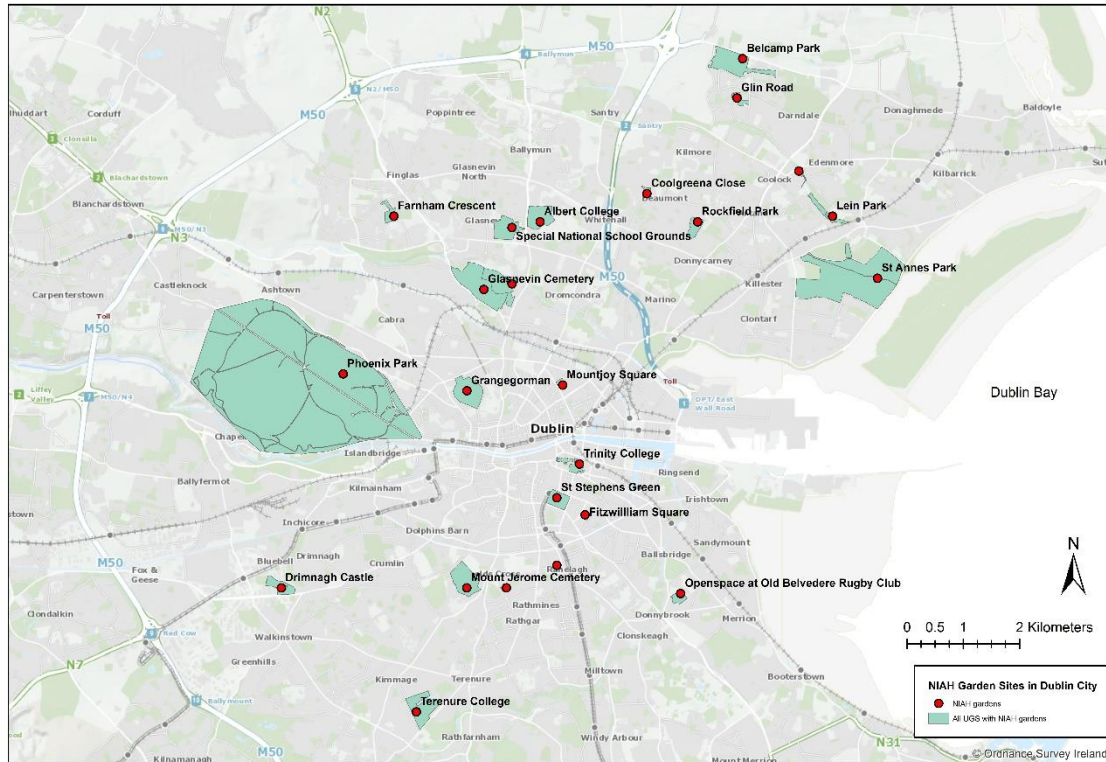
Methods: historic industrial activity



- Determine past industrial uses of UGS
 - GSI SURGE Historic Industry
 - Historic OS 6" colour maps
 - DCC UGS
 - Premium OS Basemap
 - DCC/EMRA records
 - Interviews
 - Historical accounts
 - City Archives
- Eamon Ceannt Park: refuse tip, clay pit, brick works

The perils of point data and landscape fragmentation – demesnes and current UGS

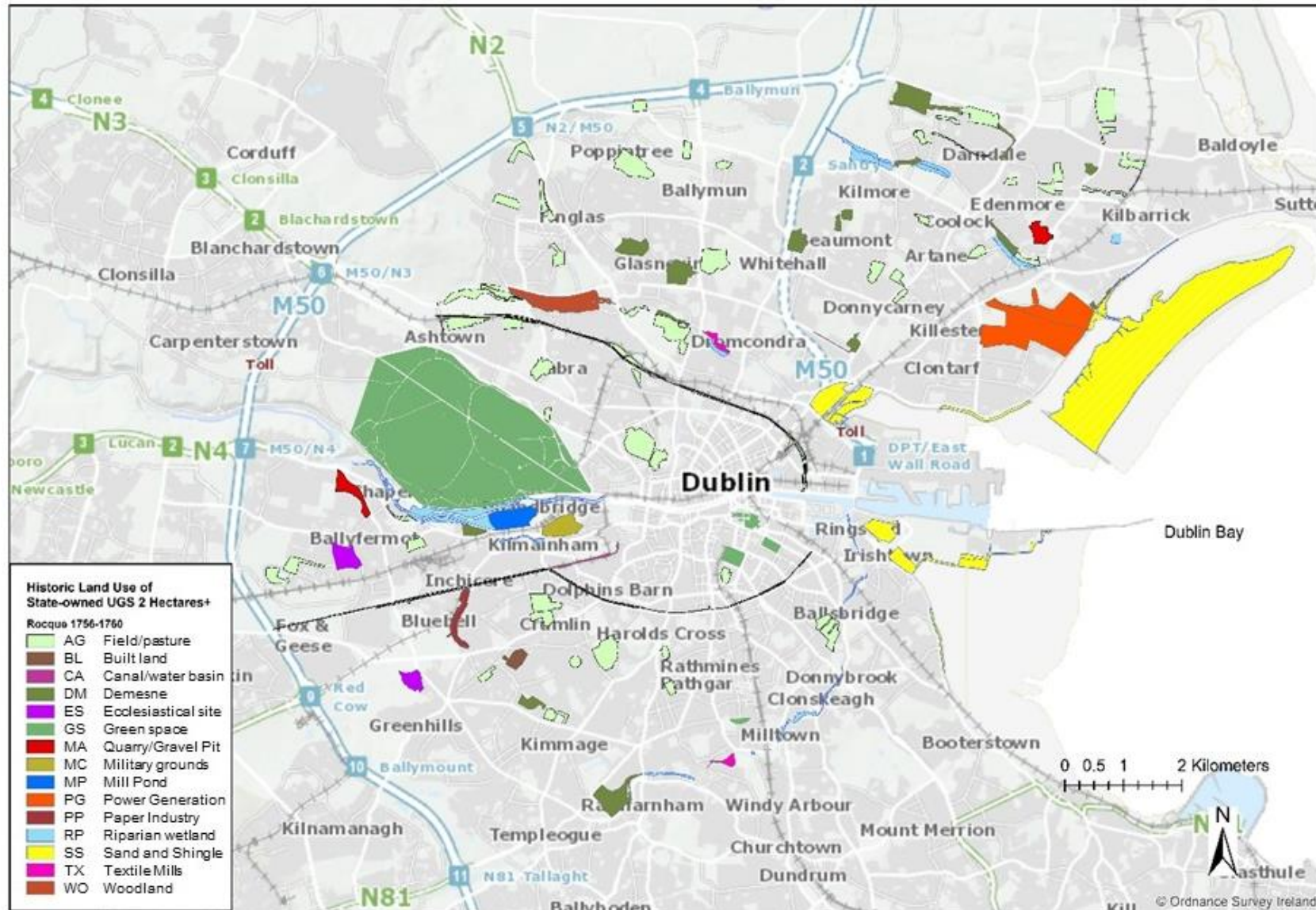
NIAH dataset is point data for where the actual houses were located (many now destroyed)



24 of the NIAH Historic Garden sites (DAHRRG, 2012) **directly intersect** with 25 of all UGS polygons mapped by DCC.

Sites (point data) of historic gardens and green spaces of national importance as listed in the National Inventory of Architectural Heritage (DAHRRG, 2012) which exist **within 100 metres of any public UGS** (n=99/113 sites).

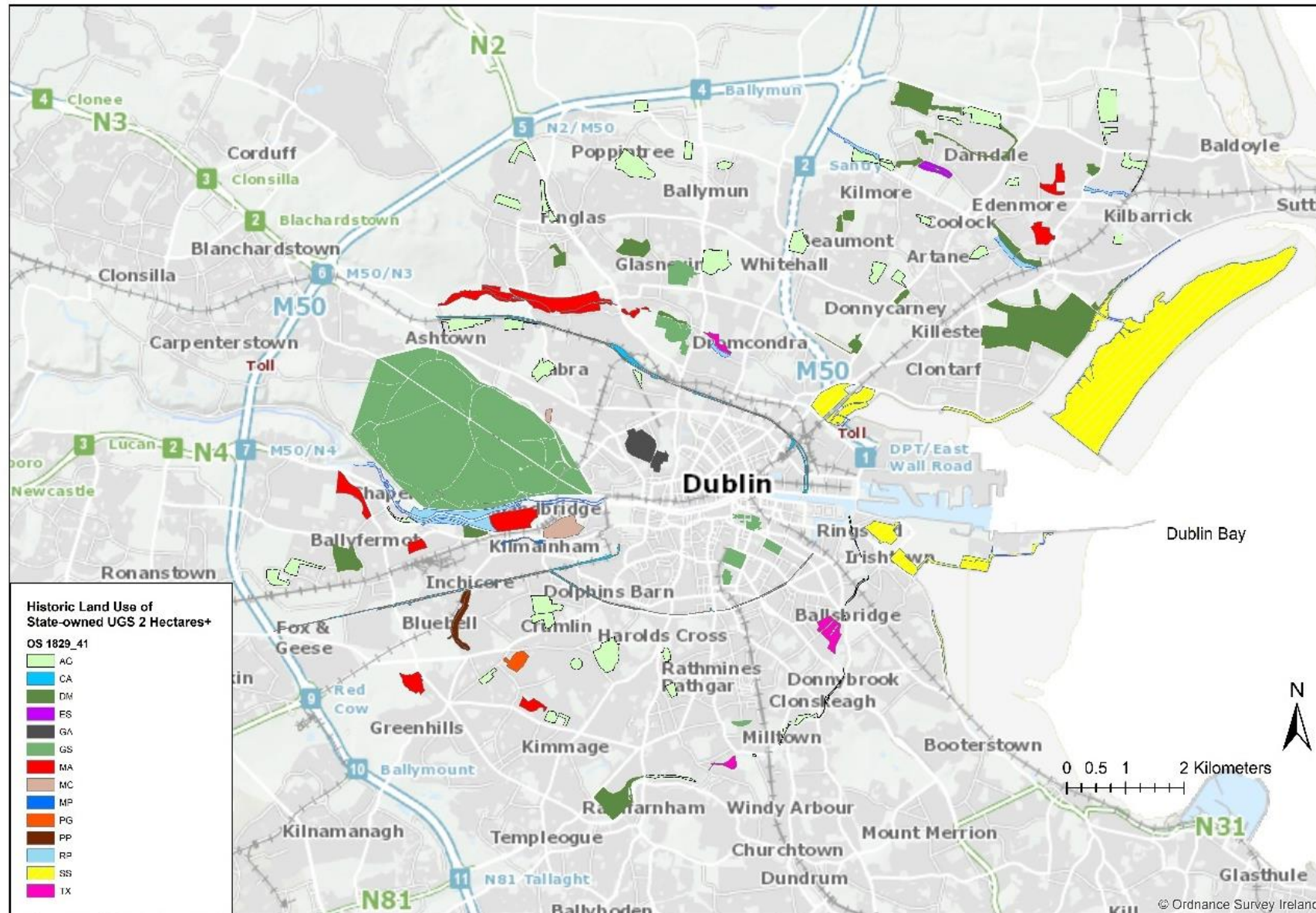
John Rocque's Maps of Dublin City and County 1757-1760



- Main UGS within the city centre originated from 1757 or earlier (Strati, 2005).
- Woodlands mainly along riparian zones and within the Phoenix Park.
- Industrial uses of the rivers:
 - Dodder = Textile manufacture (TX)
 - Camac = Pulp and paper manufacture (PP)
- Agriculture, demesnes, sand and shingle and riparian are most common land uses.

Ordnance Survey 2019

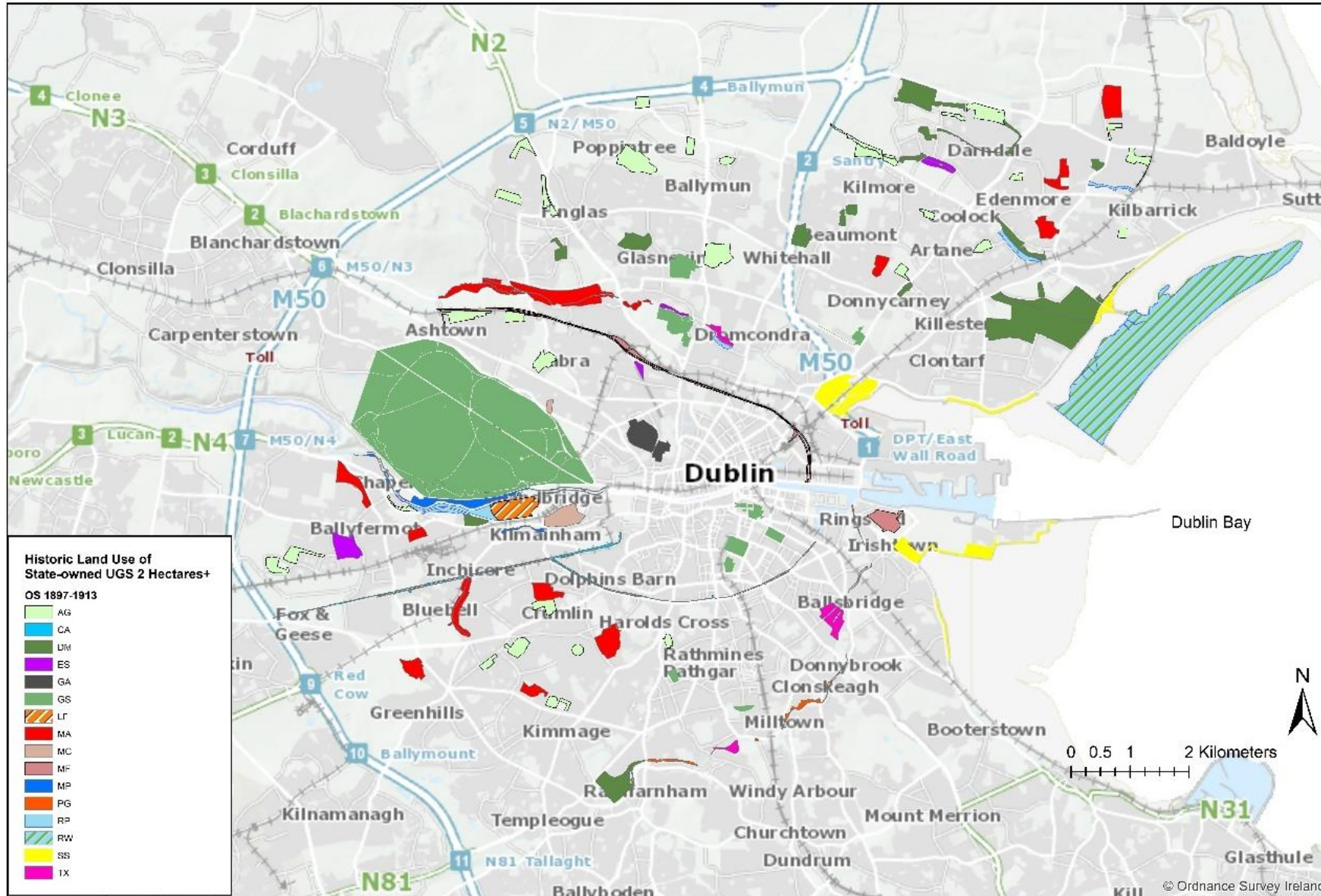
Ordnance Survey Historic 6" First Edition Colour (1829-41)



- Establishment of many industrial sites.
- Mineral extraction and quarrying (MA) were to the west and northeast.
 - Navigation and shipping
 - Construction of North Bull Wall – island formation.
 - Both canals (CA) were built.
- Demesnes (DM) were established which would eventually form the key UGS of the City.

Ordnance Survey 2019

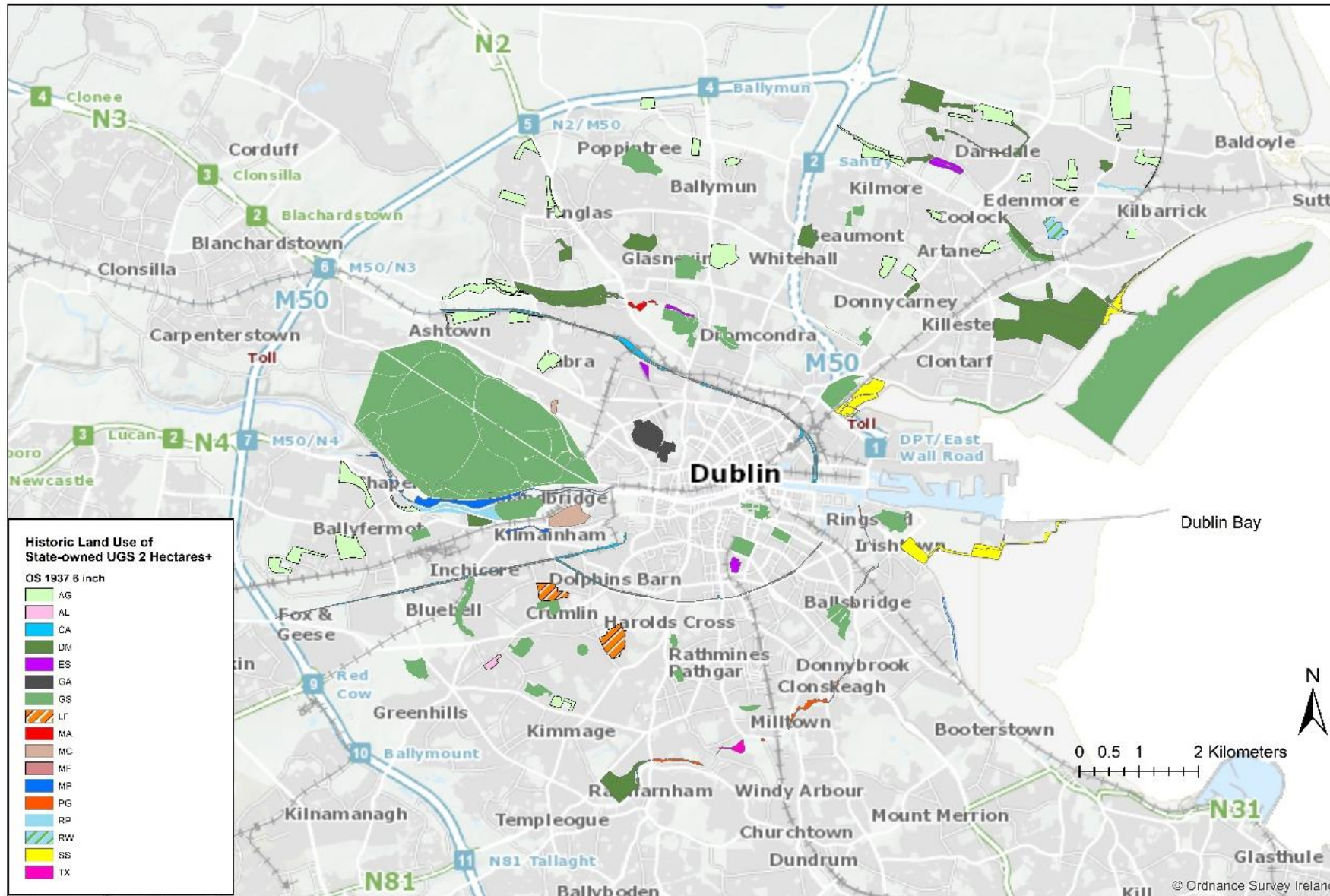
Ordnance Survey Historic 6" Last Edition B&W (1897-1913)



- Mineral extraction within the city was prohibited by legislation and the eskers to the southwest were heavily quarried as a result.
- Extensive mineral extraction and quarrying (MA) taking place in all areas except the southeast of the study area.
- The number of demesnes (DM) established on former agricultural fields in north Dublin increased.
- North Bull Island begins to extend northwards.

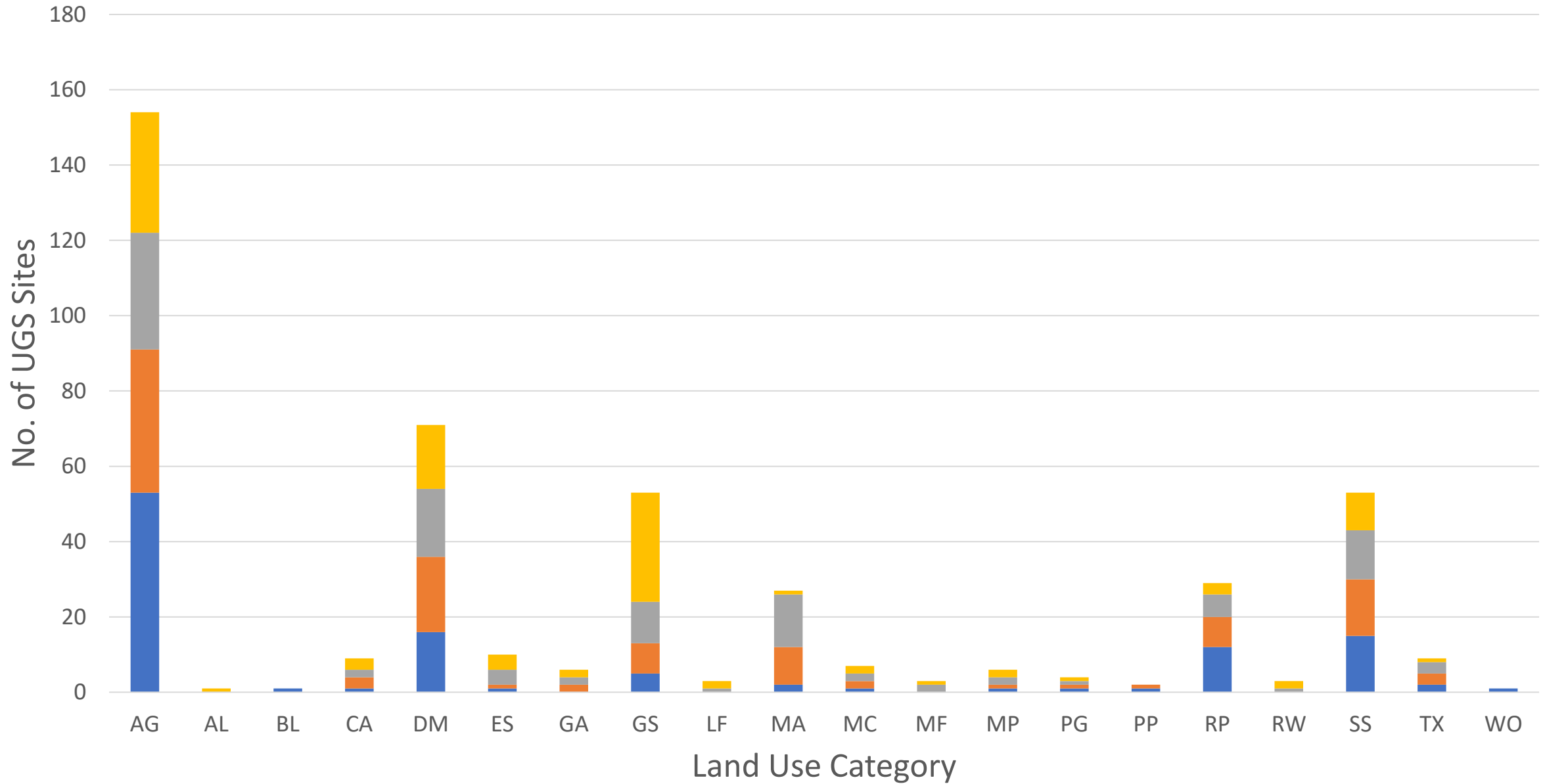
Ordnance Survey 2019

Ordnance Survey Historic 6" B&W 1937



- The sites of current UGS were predominantly green spaces (GS), demesnes (DM) and agricultural lands (AG).
- Landfills (LF) are evident to the southwest on sites of former quarries.
- Extensive areas of sand and shingle (SS) remain.

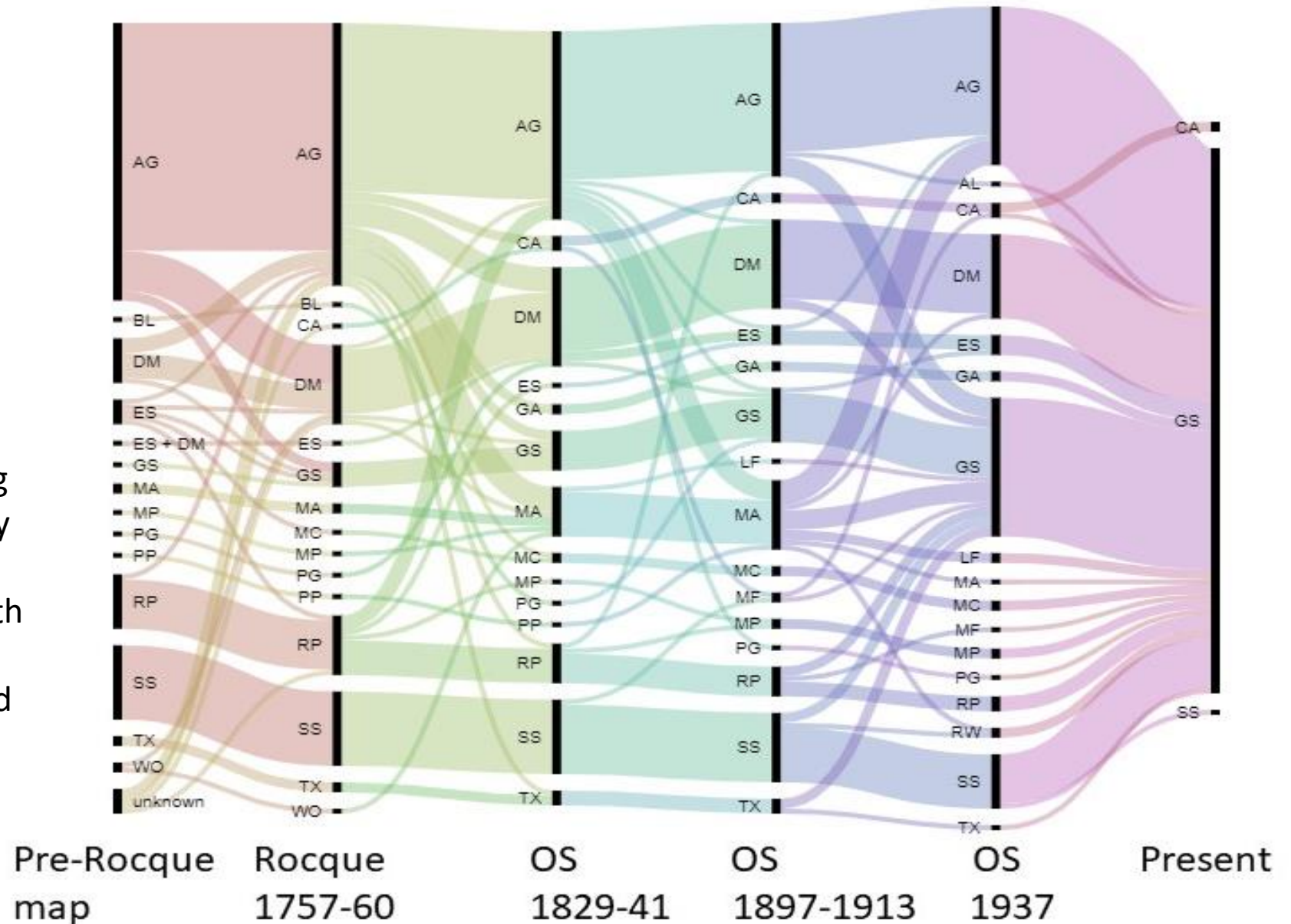
Ordnance Survey 2019



■ Rocque 1756-1760
 ■ OS 1829-41
 ■ OS 1897-1913
 ■ OS 1937 6inch

Dynamics of landscape change

“Traditional approaches measuring the degree of urbanisation in study sites often neglect the temporal dynamics of landscape change, with only the most recent spatial configuration and surrounding land uses taken into account”
 - Ramalho and Hobbs 2012



Categories of land use and biodiversity impacts

	Industrial	Built (including landfill)	Cultivated (including allotments)	Natural (area)
Description	Resource extraction	Construction, import of materials	Soil cultivation. Planting	Minimal intervention, recreational use
Impact on biodiversity	Significant alteration of habitats and resources, pollution	Removal of habitat, pollution, restriction of resource access	Active selection of vegetation composition, introduction invasive plant species	Disturbance, spread of invasive species
Habitat continuity	Significant disruption. Change in environmental habitat conditions.	Permanent alteration and removal of habitat	Permanent alteration of species composition and soil condition	Continuous. If disturbed chance of recovery and restoration
Number of sites	15	5 (built) 34 (landfill)	57	2
Total area of sites ¹	241 ha	61 ha (built) 685 ha (landfill)	1022 ha	7 ha
Percentage of total UGS ²	12%	37%	51%	< 1%

In summary

- The result that most of the public UGS (62%) were urbanised since 1945 means that ecological succession after disturbance is still in the early stages.
- Dublin City has highly fragmented UGS which are highly intensified in terms of land use and present challenges to maintaining ecological networks.
- Dublin's biodiversity relies on few large UGS within dense urban matrix.
- Waste disposal sites found 35 locations –mainly wetlands – identified 20 new sites not in EMWR report of historic or legacy landfills.
- Reliance upon single datasets can result in gaps e.g. NIAH point data.

Discussion

- Some urban-related effects do not decrease in intensity in a simple linear or concentric pattern from a single centre (McIntyre et al 2000).
- When planning Nature-Based Solutions historical land-use represents both opportunities and potential limitations:
 - Sites of demesnes (DM) important for habitat continuity supports earlier studies in south Co. Dublin (Kingston et al. 2003)
 - Many natural areas maintaining ecosystem functions and services, particularly wetlands, have a history of waste disposal.

Recommendations

- Examine private UGS as a support for biodiversity.
- The resulting database identified areas that could be targeted for ecological restoration and nature-based solutions.
- Further work planned to assess in more detail the relationship between historical land uses and current biodiversity.

Acknowledgements

Environmental Protection Agency

Dublin City Council

Principal Supervisor: Dr. Tamara Hochstrasser, UCD

Doctoral Studies Panel: Prof. Thomas Bolger, UCD

Dr. Claire Cave, UCD

Dr. Karen Foley, UCD

Contact: maryann.harris@ucdconnect.ie



References

- Cohen-Shacham, E., G. Walters, C. Janzen, S. Maginnis (eds). 2016. Nature-based solutions to address global societal challenges. Gland, Switzerland: IUCN. Xiii + 97 pp.
- DAHRRG 2012. Historic Gardens Survey. 2017 ed. Dublin, Ireland: Department of Arts, Heritage, Regional, Rural And Gaeltacht Affairs (DAHRRG).
- DCC 2014 North Bull Island UNESCO Biosphere Periodic Review Report. Dublin City Council (DCC).
- Forrest, M. 2011. Allotments in Dublin 1900-1950. *Irish Geography*, 44, 265-290.
- Forrest, M. 2013. Plots and Plotolders in Dublin 1909-1950. *Dublin Historical Record*, 66, 3-11.
- Glennon, M., Scanlon, R., O'Connor, P. 2012. Dublin SURGE Project database. Dublin, Ireland: Geological Survey of Ireland.
- MCDONALD, R., COLBERT, M. L., HAMANN, M., SIMKIN, R. & WALSH, B. 2018. Nature in the Urban Century: A global assessment of where and how to conserve nature for biodiversity and human wellbeing. Arlington, VA, USA: The Nature Conservancy.
- MCINTYRE, N. E., KNOWLES-YÁNEZ, K. & HOPE, D. 2000. Urban ecology as an interdisciplinary field: differences in the use of “urban” between the social and natural sciences. *Urban ecosystems*, 4, 5-24.
- ONANDIA, G., SCHITTKO, C., RYO, M., BERNARD-VERDIER, M., HEGER, T., JOSHI, J., KOWARIK, I. & GESSLER, A. 2019. Ecosystem functioning in urban grasslands: The role of biodiversity, plant invasions and urbanization. *PLOS ONE*, 14, e0225438.
- Perrin, P.M. & Daly, O.H. (2010) A provisional inventory of ancient and long-established woodland in Ireland. *Irish Wildlife Manuals*, No. 46. National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland.
- RAMALHO, C. E. & HOBBS, R. J. 2012. Time for a change: dynamic urban ecology. *Trends Ecol Evol*, 27, 179-88.
- Strati, I. 2005. Historical Geographies of Dublin's Public Green Spaces, from Their Origins to 1756. Doctoral thesis. Department of Geography, Trinity College Dublin.
- UNESCO 2016. Culture: urban future; global report on culture for sustainable urban development; summary. In: BOKOVA, I. (ed.). Paris, France: UNESCO.

Symbol	My category	Group	GSI Description	GSI Type	GSI Abb.
AG	Agricultural/pasture	Cultivated	n/a	n/a	AG
AL	Allotment	Cultivated	n/a	n/a	
BL	Built land	Built	n/a	n/a	BL
GA	Gaol/asylum/ execution	Built	n/a	n/a	
CA	Canal/water basin	Built	n/a	n/a	
CH	Chemical	Industrial	Glass House Factory	Chemical	CH
CH	Chemical	Industrial	Printing Office	Chemical	CH
DM	Demesne	Cultivated	n/a	n/a	DM
ES	Ecclesiastical site/church/cemetery	Cultivated	n/a	n/a	ES
FU	Fuel	Industrial	Coal Yard	Blank	FU
FU	Fuel	Industrial	Gasometer	Oil-Gas Industry	FU
GS	Green space	Cultivated	n/a	n/a	GS
LF	Landfill	Landfill	Refuse Depot	MF	LF
LF	Landfill	Landfill	Refuse Tip	MF	LF
MA	Brick-Clay	Industrial	Brick Works	M&A	BC
MA	Brick-Clay	Industrial	Clay Pit	M&A	BC
MA	Gravel Pit	Industrial	Gravel Pit	M&A	GR
MA	Lime Kiln	Industrial	Lime Kilns	M&A	LK
MA	Quarry	Industrial	Quarry	M&A	QU
MC	Military grounds	Built	n/a	n/a	MC
MF	Municipal Facilities (MF)	Industrial	Cleansing Depot	MF	MF
MF	Municipal Facilities (MF)	Industrial	Pumping Station	MF	MF
MF	Municipal Facilities (MF)	Industrial	Syphon House	MF	MF
MF	Municipal Facilities (MF)	Industrial	Water Works Pressure Station	MF	MF
MG	Manufacturing and Goods	Industrial	Factory	Blank	MG
MG	Manufacturing and Goods	Industrial	Goods Shed	Blank	MG
MP	Mill Pond	Industrial	Mill Pond	Blank	MP
MT	Metal Industry (MT)	Industrial	Smithy	MT	MT
MW	Monumental Works (MW)	Industrial	MW	Blank	MW
PG	Power Generation (PG)	Industrial	Electricity Station	PG	PG
PG	Power Generation (PG)	Industrial	Engine House	PG	PG
PG	Windmill	Industrial	Windmill	Food	WM
PP	Pulp-Paper Industry (PP)	Industrial	Axle Tree Mill	PP	PP
PP	Pulp-Paper Industry (PP)	Industrial	Sawmill	PP	PP
RP	Riparian wetland	Natural	n/a	n/a	
RW	Reclaimed wetland	Built	n/a	n/a	RW
SS	Sand and Shingle	Natural	n/a	n/a	SS
TX	Textile and Woollen Mills	Industrial	Laundry	Textile	TX
WO	Woodland	Natural	n/a	n/a	WO

Specific land uses of each UGS over time are analysed for each map.

Land uses are then summarised into ‘Group’ categories to simplify the analysis as follows:

- **cultivated** - includes agricultural fields, orchards, gardens, demesnes, churchyards;
- **natural areas** - includes unmodified riparian wetlands, sand and shingle beaches, woodlands;
- **built** - includes buildings, enclosed yards such as military and cavalry grounds, reclaimed wetlands, canals and associated embankments, gaols, prisons and grounds for public executions and punishments; landfill – includes all waste disposal sites
- **industrial** - includes all land uses as defined by the Geological Survey of Ireland SURGE dataset as industrial activities

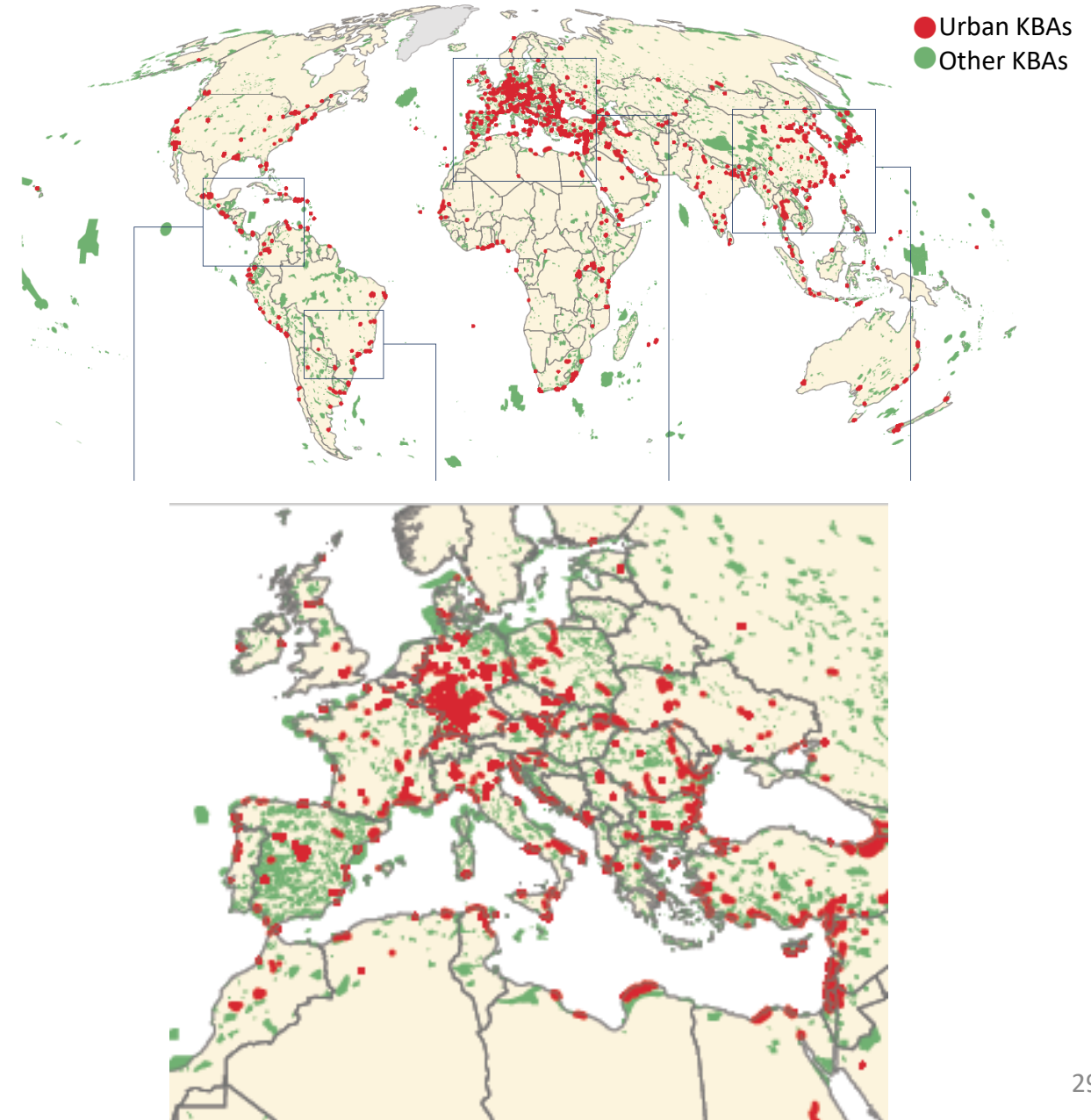
Conclusions/Take Home Messages

- Recent urbanisation in Dublin has impacts
- Land use change occurs on a continuum
- Phases of urbanisation are evident with periods of intensity and rapid changes on ecosystem
- Patterns of urbanisation are not concentric and a uniform gradient is not evident

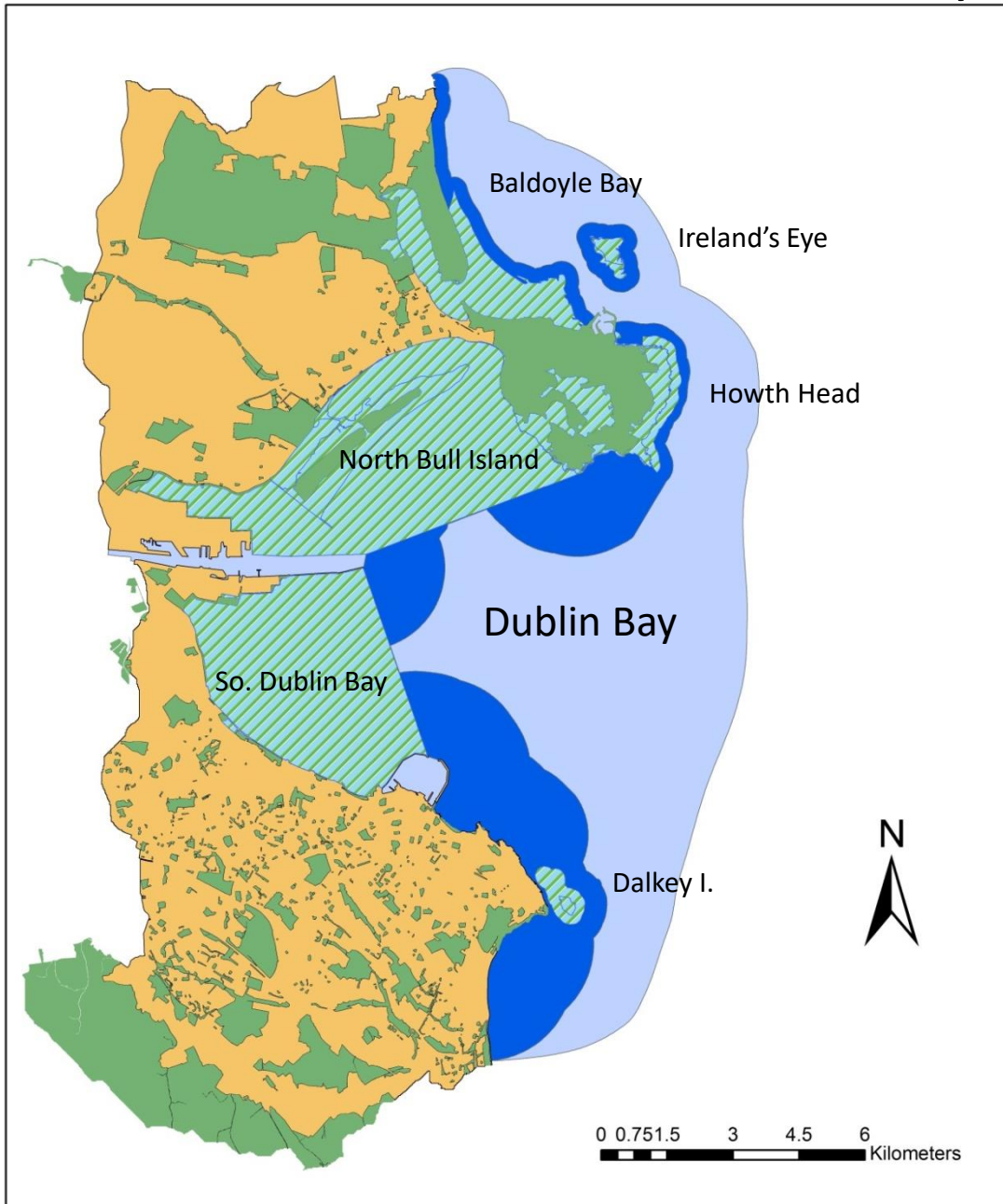
Biodiverse cities

- Cities have important biodiversity.
- Dublin City has biodiversity of global importance and is identified as an Urban Key Biodiversity Area.
- KBAs that will be impacted by urban growth are shown (top), where impact is defined as having more than 5% of their area urbanised by 2030.
- 10% of KBAs are affected.
- Many of these urban-impacted KBAs are found in Europe – including Dublin.

(McDonald et al 2018; IUCN 2020)



Dublin Bay UNESCO Biosphere



Zonation of Dublin Bay UNESCO Biosphere



terrestrial buffer = 51.6 km²

- **UGS as a buffer zone** to support nature conservation for core area.
- Requires an **ecosystem-based approach to UGS management in Dublin City.**
- Example of **'urban biosphere'** (UNESCO 2016).

Source: DCC 2014

Nature-based solutions concepts IUCN (2016)

Category of NBS approaches	Examples
Ecosystem restoration approaches	Ecological restoration; Ecological engineering; Forest landscape restoration
Issue-specific ecosystem-related approaches	Ecosystem-based adaptation; Ecosystem-based mitigation; Climate adaptation services; Ecosystem-based disaster risk reduction
Infrastructure-related approaches	Natural infrastructure; Green infrastructure
Ecosystem-based management approaches	Integrated coastal zone management; Integrated water resources management
Ecosystem protection approaches	Area-based conservation approaches including protected area management