

Media Pressures in Welsh Language Acquisition and Transmission

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Abstract

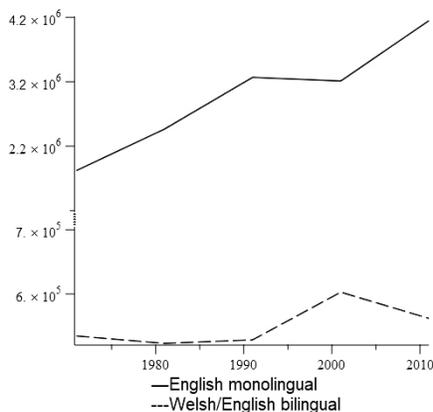
Despite universal school instruction in the Welsh language, and strong cultural incentives to acquire the language, the most recent UK Census showed a downward trend in the number of speakers. The asymmetry in explicit language acquisition incentives is here considered to be offset by the media dominance of the English language. This dominance is modelled by the introduction of a time-dependent connectivity amongst English speakers into an adapted epidemiological model. Extrapolations up to 2050 are made, this being the announced date of a Welsh Assembly language-planning target of one million Welsh speakers.

Key Words: Bilingualism, Language Death, Language Planning, Media, Digital Media, Mathematics, Modelling.

1 Introduction

Mathematical work on language group dynamics has its modern origin in that of Baggs and Freedman (1990, 1991, 1993), employing a predator-prey paradigm realised in a system of differential equations. After interest in the topic had been revived by Abrams and Strogatz (2003), Wyburn and Hayward (2008) revisited the model of 1990 and showed that this generates all the long-term scenarios of interest to the bilingual community, i.e. language death, maintenance, prestige, and shift. The model was applied to the case of Wales, and it was concluded that the language was likely to achieve “shift”, *i.e.* that bilingualism would become universal. The same authors, using the alternative methodology of system dynamics, produced similarly optimistic results (Wyburn and Hayward 2009). Kandler *et al* (2010), in a model that took into account both temporal and spatial evolution, came to the more cautious conclusion that Welsh-language survival was conditional on both the creation of dedicated social domains, and the maintenance of intergenerational transmission rates.

A certain optimism seemed well-founded in that pro-Welsh language planning activity in Wales was, and is, strongly supported both by central government initiatives and by cultural awareness (see e.g. WAG (2017)). The 2011 UK Census, however, indicated a drop in the number of speakers (Figure 1).



This paper presents a model explicitly addressing the interaction and evolution of populations, distinguished by their language use, within modern

Wales, and uses this to extrapolate current trends and possible alternative scenarios into the near and far future. The paradigm adopted is epidemiological.

2 The Model

A simple epidemiological model of the acquisition of Welsh would have the following structure:

$$\frac{dx_E(t)}{dt} = (b-d)x_E(t) - \left(\frac{b-d}{K-x_B(t)}\right)x_E(t)^2 - ciB\left(\frac{x_B(t)}{x_E(t)+x_B(t)}\right)x_E(t) + rx_B(t)$$

$$\frac{dx_B(t)}{dt} = (b-d)x_B(t) - \left(\frac{b-d}{K-x_E(t)}\right)x_B(t)^2 + ciB\left(\frac{x_B(t)}{x_E(t)+x_B(t)}\right)x_E(t) - rx_B(t)$$

The analogous disease would be both congenital and contagious, but permitting of a cure. Here x_E , the population of monolingual English speakers, is the susceptible and x_B , that of bilingual Welsh/English speakers, the infected population. The element $(b-d)x_E(t) - \left(\frac{b-d}{K-x_B(t)}\right)x_E(t)^2$ models the natural increase of the susceptible population $b-d$. The form of the logistic term is owing to Kandler *et al*, and ensures that the sum of the two populations will not exceed the carrying capacity $x_E + x_B \leq K$. The corresponding element for the infectives x_B controls the congenital contribution. The factor $ciB\left(\frac{x_B(t)}{x_E(t)+x_B(t)}\right)x_E(t)$ models those members of the unilingual population that acquire (“contract”) Welsh, due to contact c with the Welsh proportion of the population $\frac{x_B(t)}{x_E(t)+x_B(t)}$ at an infectivity rate i_B . There is no equivalent term describing transition from x_B to x_E , because all members of this population are bilingual in English and Welsh (English, analogously, is an universal sickness).

The analogue of simple recovery $rx_B(t)$ depends on the use of Welsh being abandoned after some time $1/r$, the circumstance of “linguistic attrition” which is of considerable concern to Welsh language planning (see *e.g.* Jones (2012, page 63). As such it is more properly comparable to the effects of a sparsely distributed remedy. This model has some interesting features, notably an equilibrium at

$$\left(x_B = K \frac{(ci_B - i_E)}{(ci_B)}, x_E = \frac{Ki_E}{(ci_B)}\right)$$

which is stable under the following eigenvalue conditions

$$-ciB + iE < 0, \quad -HB - HE - 2b + 2d < 0$$

The simple recovery model may therefore be of interest under circumstances of monotonic change, and it can reproduce the trends of Abrams and Strogatz (2003), Wyburn and Hayward (2008). However, assuming realistic demographic parameters, it is not capable of modelling the behaviour observed in Wales over the last three censuses (nor can it model behaviour prior to 1981, when there was a substantial monoglot Welsh population).

The non-monotonic behaviour observed since 1991 therefore requires the introduction of a new mechanism. That this mechanism entails a change in the infectivity analogue i_B seems likely. Certainly, the behaviour of both populations is adequately modelled by a linear infectivity $ci_B(t) = 0.032 - 0.0029t$. However, this would entail a negative infectivity after 11 years, and does not suggest a mechanism for the change. If, however, the epidemiological factor is distributed over the linear infectivity, the equations can be rewritten as follows:

$$\begin{aligned} \frac{dx_E(t)}{dt} &= (b - d + H_E)x_E(t) - \left(\frac{b - d + H_E}{K - x_B(t)}\right)x_E(t)^2 \\ &\quad - \alpha \left(\frac{x_B(t)}{x_E(t) + x_B(t)}\right)x_E(t) + \beta \left(\frac{x_E(t)}{x_E(t) + x_B(t)}\right)x_B(t) \quad (1) \end{aligned}$$

$$\begin{aligned} \frac{dx_B(t)}{dt} &= (b - d + H_B)x_B(t) - \left(\frac{b - d + H_B}{K - x_E(t)}\right)x_B(t)^2 \\ &\quad + \alpha \left(\frac{x_B(t)}{x_E(t) + x_B(t)}\right)x_E(t) - \beta \left(\frac{x_E(t)}{x_E(t) + x_B(t)}\right)x_B(t) \quad (2) \end{aligned}$$

Here explicit migration terms H_E, H_B have been added, since these are of particular importance in the case of Wales, and $\alpha = ci_E, \beta = ci_B$. The decision to combine the contact c and infectivity i parameters was taken because the total population $x_E + x_B$ is by no means homogeneous; Jones (2012, page 18) cites an index of isolation (the likelihood of one Welsh speaker meeting another at random) of 0.374 for 2001. Therefore, it is more convenient to let a compound term encompass the parameters involved. Moreover, the interpretation of β requires particular attention.

The form of (1), (2) is suggestive that while Welsh acquisition depends on constant factors, especially language planning fiat, that are directly comparable to elements in traditional epidemiology, “recovery” is dependent on a strongly dynamic factor which is increasing in strength with time. Since we cannot interpret the component β as infectivity by contact in this context—there is no need to acquire English— it is rather English monolingual culture which is adopted; the term “allure” might be used. Welsh bilinguals abandon the use of Welsh, and this is intrinsically easier and more rapid than the reverse process, which necessitates language acquisition. Therefore, effective contact might be relatively casual, and c have a correspondingly high value. The nature of the dynamic factor is therefore suggested to be the pervasiveness of English media, and the parameter β a measure of increasing connectivity c in respect of this, and an index of the allure of English monoglot culture i_E .

By 1981 English was already the principle language of modern media and entertainment in Wales, but over the last thirty years its dominance has become overwhelming. This is true despite the creation of dedicated Welsh-language television (Sianel Pedwar Cymru, 1982) and radio (Rado Cymru, 1977). The average home in Wales now has several media inputs, notably multi-channel television, the Internet, and to a lesser extent radio and print media, in which the dominant language of available programming is English (see especially Baker (2007, Chapter 8) and Baker & Prys Jones (1998, pp.60-63)). In the words of Krauss (1992) these are sources of “cultural nerve gas” in respect of a dominant language (Krauss refers specifically to television, but the argument extends to all media). This form of mass-media participation is of course passive. However, social media interactions, which require the active use of the language involved, will also typically be conducted in English; a 2015 survey found that over 80% used English in email and social media (Facebook, Twitter), and over 74% English when texting (WAG& WLC 2015a). This despite the provisions made as part of the “Welsh-language technology and digital media action plan” (WAG 2013). An examination of digital media outlets will therefore be of some use in examining β . Figure 2 has been constructed from data pertaining to ONS (2016a, Figure 13); values for the years 1998-2004 have been corrected from Great Britain to the United Kingdom.

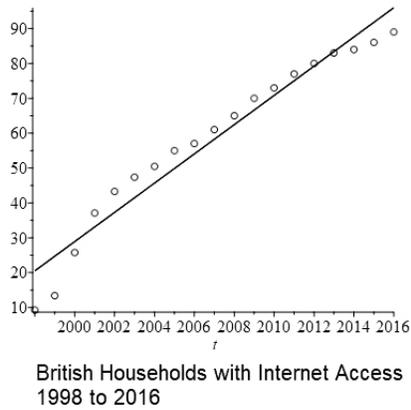


Figure 2 Uk Percentages of UK Households with Internet access 1998-2016
 At an $R^2 = 0.9489$, the linear fit $y = 4.1921t - 8355.3$ is a reasonable approximation. Figure 3 has been similarly put together with data from ONS (2016b, Figure 10)

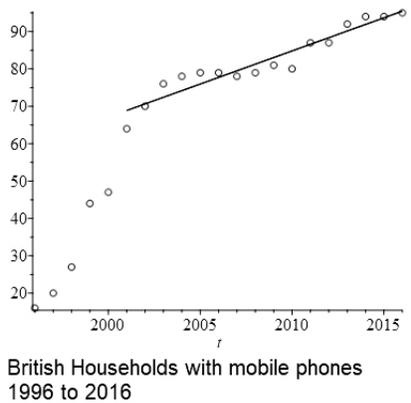


Figure 3 Percentages of UK Households with mobile telephones 1998-2016
 While the data as a whole is by no means linear, but shows the saturation of the market, the period from 2001 is well modelled ($R^2 = 0.9087$) by $y = 1.7721t - 3477.1$, and that before might be given a steeper straight line. Possibly the whole period might be well approximated by the Bass model

(Bass, F. 1969), though this would greatly complicate the present model.

Of course, it is not the English-speaking population of Wales alone that produces all English-language media. If, however, the population x_E is considered as the set of consumers of such media, their number is a suitable gauge of the proportion immediately available to their Welsh-speaking neighbours. Similarly, the total population $x_E + x_B$ would represent the total consumption of media both Welsh and English; but the x_B component is likely to be very small, and the fraction $\frac{x_E}{x_E+x_B}$ close to unity.

3 Analysis of the Model

For a suitably advanced value of t , the x_B nullclines have the forms:

$$x_{B01} : x_B = 0$$

$$x_{B02} : x_B = -x_E + m_1 + m_2 \sqrt{m_3 x_E^2 - m_4 x_E + m_5}$$

$$x_{B03} : x_B = K$$

and the x_E nullclines

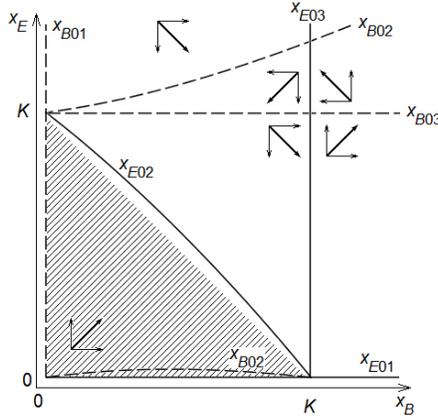
$$x_{E01} : x_E = 0$$

$$x_{E02} : x_E = -x_B + n_1 + n_2 \sqrt{-n_3 x_B^2 + n_4 x_B + n_5}$$

$$x_{E03} : x_E = K$$

and typically of epidemiological models, the point $(0, 0)$ is unstable, whereas $(0, K)$ and $(K, 0)$ represent the only stable values (Figure 4; the vectors are easily established by experiment).

The eigenvalues of the Jacobian for $(0, K)$ are $E_{(0,K)1} = -(b - d + H_E)$ and $E_{(0,K)2} = (b - d + H_B) - \beta t + \alpha$. $E_{(0,K)1}$ may be assumed to be negative (the population is assumed to be demographically healthy), but $E_{(0,K)2}$ will certainly become negative as time t increases. The corresponding eigenvalues for $(K, 0)$ are $E_{(K,0)1} = \frac{(-b-d-H_B)K+2Kd}{K}$ and $E_{(K,0)2} = \beta t - \alpha + (b - d + H_E)$. Whatever the former, $E_{(K,0)2}$ will become positive with time; bilingual cultural dominance occurs at an unstable point.



Under these circumstances, there is no long-term compromise of the nature of maintenance or prestige (Wyburn and Hayward 2008). Although the vector drift is not strong in the bulk of the viable area (shaded in Figure 4), for which $x_E + x_B \leq K$, these stable scenarios are not so distant as to be unable to inform or affect current policy. Whatever the educational (static, traditionally epidemiological) advantages of the x_B population, the growth of connectivity of the x_E population will certainly negate and overpower these. This effect can be observed over the time scale (years to decades) in which a planning policy may reasonably be expected to remain consistent.

4 Application of the Model

On 11/07/2017 the Welsh Assembly published *Cymraeg 2050* (WAG 2017), consolidating plans to increase the number of Welsh speakers from 562,000 (that of the 2011 Census, and inclusive of all ages 3 and above) to 1,000,000 by 2050. This commitment makes the next three decades a critical time in the history of the Welsh language. What can the present model tell us about the likelihood of success?

The demographics found by fitting the logistic curve to the total population $x(t) = x_E(t) + x_B(t)$ over the period 1981-2011 are $b - d - H = 0.02824$ and $K = 3,130,000$. The small carrying capacity K is surprising; however, Wyburn and Hayward (2008) assume a carrying capacity for Wales of four

million, and note that this is supported by the low natural increase rate. Taking $b = 0.01343$ and $d = 0.01204$ from the 1991 Census figures, this leaves a substantial inward (positive) migration of $H = 0.02685$. That the migration rate should be proportional to the population is not intuitive, but successful here. However, migration is not equal over the two populations. Jones (2012, pp.111-113) notes that “we can estimate that 3,600 Welsh speakers migrated into Wales during the 12 months before the Census In the 12 months before the 2001 Census some 5,200 Welsh speakers, perhaps, had migrated out of Wales”. This would give a rough figure for $H_B = -0.001$, taken to be effectively zero over the period, and therefore $H_E = 0.03532$. Precision to the fourth decimal place is surely unwarranted over the fifty-nine years (1991-2050) to be examined, and hence the model demographics employed are:

Demographic	value used
b	0.013
d	0.012
H_B	0
H_E	0.035
K	3130000

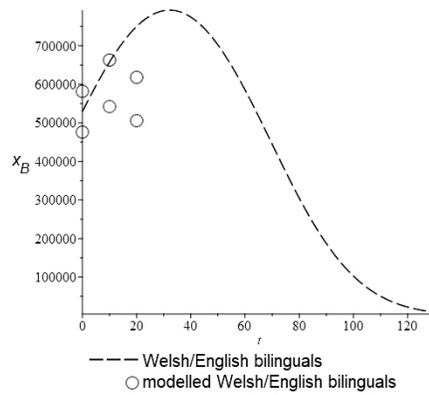
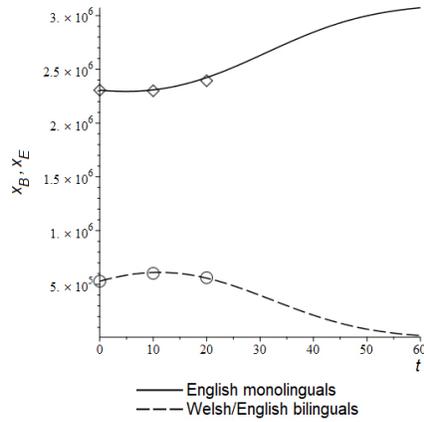
Table 1 Demographic values used in the model

The model can be tested against census data (H.M.S.O. 1891-1991) as in Figure 5. Values of $\alpha = 0.032, \beta = 0.0029$ adequately reproduce the observed behaviour.

If we take the projection at face value, the recent fall is symptomatic of a rapid decline in the number of Welsh speakers, and effective extinction in 60 years, *i.e.* by 2051.

The conclusion is little affected by increasing α while this remains a constant term. The National UK Census figures are the lowest of the three typically quoted; ONS (2011) quotes 787,500 speakers, and WAG (2015b) 673,700. However, even allowing an uncertainty of around $\pm 20\%$, only a considerably higher value of x_B in 2011 could have been indicative of the survival of Welsh for as little as 90 more years (Figure 6).

Figure 6 Survival until the year 2101 require a higher x_B in 2011 than even the highest estimate permits



However, Welsh-language acquisition is a matter of extended personal encounter, typically formal (pupil and teacher, adult learner and lecturer), whereas English-language culture is one of relatively short virtual encounter through digital and other media. Under these circumstances, little can be done to remedy the situation.

5 Conclusion

Of course, an act of will can overcome any obstacles with respect to language preservation; the case of modern Israel is the exemplar (Harshav, B. 2009). However, that the number of Welsh speakers is declining is a clear indication that the will is lacking in this case.

The policy outlined in Cymraeg 2050 explicitly considers the issues of the prevalence and nature of Welsh-language media. It is encouraging in the present context that the importance of entertainment and digital media is addressed, with the commitment to enable Welsh to “become more prevalent in popular culture in all its art forms, in literature, theatre, film and television” and to “ensure that the Welsh language is at the heart of innovation in digital technology to enable the use of Welsh in all digital contexts” (WAG 2017, p.64, 71) .

The difficulty of this as things stand cannot be overstated. While it may indeed be realistic to supplement English with Welsh-language media for domestic consumption, it is difficult to see that this can be done at more than current levels without prohibitive costs. The emphasis of Kandler *et al* (2010) on dedicated domains is certainly valid, and this may translate well to the online community; certainly Welsh-language websites encourage active production of Welsh-language material. However, the present author has failed to identify any domain of sufficient popularity that may be exclusively and productively dedicated to the Welsh language.

Possibly the resolution may depend not on pro-Welsh measures *per se*, but on the challenge to English-language dominance by cheap and effective real-time translation software. Sponsored by the Welsh Assembly, Williams *et al* (2017) have written open-source Welsh translation software intended for online businesses and communities, and Google Translate has a Welsh text editor that continues to improve. Skype Translator is an application of neural networks which has been commercially available since 2014, and which at the time of writing facilitates conversations between Arabic, English, French, German, Italian, Japanese, Mandarin Chinese, Portuguese, Russian and Spanish users. Since Welsh is not currently demanded by the general business community, Skype’s extension to *yr hen iaith* would have to be a matter of subsidy, but it is certainly technically possible.

If the above were achieved, then the “allure” of Welsh bilingual culture (or even, conceivably, of Welsh unilingual culture) would be enabled to grow at the same rate as English, since (originally) English-language media would be effectively suborned to the service of Welsh. The model could be modified such that α , like β becomes a linear function of time;

$$\begin{aligned} \frac{dx_E(t)}{dt} = & (b - d + H_E)x_E(t) - \left(\frac{b - d + H_E}{K - x_B(t)}\right) x_E(t)^2 \\ & - \alpha t \left(\frac{x_B(t)}{x_E(t) + x_B(t)}\right) x_E(t) + \beta \left(\frac{x_E(t)}{x_E(t) + x_B(t)}\right) x_B(t) \quad (3) \end{aligned}$$

$$\begin{aligned} \frac{dx_B(t)}{dt} = & (b - d + H_B)x_B(t) - \left(\frac{b - d + H_B}{K - x_E(t)}\right) x_B(t)^2 \\ & + \alpha t \left(\frac{x_B(t)}{x_E(t) + x_B(t)}\right) x_E(t) - \beta \left(\frac{x_E(t)}{x_E(t) + x_B(t)}\right) x_B(t) \quad (4) \end{aligned}$$

and under these circumstances the symmetry demands a stable equilibrium point such that $x_B + x_E = K$, while neither population need be zero.

The necessary requirement under even these most favourable circumstances is to establish sufficiently many dedicated Welsh-users to usefully exploit automated translation. As things stand, the opportunity to do so looks like it is being missed.

References

- Abrams, D. M., and Strogatz, S. H. (2003) Modeling the dynamics of language death. *Nature* 424 (6951): 900
- ONS, NOMIS (2011) *The Annual Population Survey*. Available at: <https://www.nomisweb.co.uk/articles/676.aspx> (Accessed: 11 August 2017)
- Baggs, I. and Freedman, H.I. (1990). A Mathematical Model for the Dynamics of Interactions between a Unilingual and a Bilingual Population: Persistence Versus Extinction. *Journal of Mathematical Sociology* 16(1): 51-75.
- Baggs, I. and Freedman, H.I. (1991). Convergence to Equilibria in General Models of Unilingual-Bilingual Interactions. In *Lecture Notes in Biomathematics vol. 92, "Differential Equations Models in Biology, Epidemiology and Ecology"*, edited by S. Busenberg and M. Martelli.
- Baggs, I. and Freedman, H.I. . (1993). Can the Speakers of a Dominated Language Survive as Unilinguals?: A Mathematical Model of Bilingualism. *Mathematical Computational Modelling* 18(6): 9-18
- Baker, C. & Prys Jones, S. (1998). *Encyclopedia of bilingualism and bilingual education*. Clevedon, Avon, UK: Multilingual Matters, 1998.
- Baker, C. A. (2007) *A Parents' and Teachers' Guide to Bilingualism: Third Edition*. Clevedon, UK: Multilingual Matters.
- Bass, Frank (1969). A new product growth for model consumer durables. *Management Science* 15 (5): 215-227.
- The Censuses of 1891, 1911, 1921, 1931, 1951-2011*. Office of Population Censuses and Surveys, H.M. Stationery Office.
- Harshav, B. (2009). Flowers Have No Names: The revival of Hebrew as a living language after two thousand years was no miracle. *Natural History* 118 2429.
- Jones H. (2012). *A statistical overview of the Welsh language*. Cardiff, Welsh Language Commissioner. Available at: <http://www.comisiynyddygyymraeg.cymru/English/Policy>,

- Kandler, A., and Steele, I. (2008). Ecological models of language competition. *Biological Theory* (3) 164-173.
- Kandler A., Unger R., and Steele, J. (2010). Language shift, bilingualism and the future of Britain's Celtic languages. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365(1559): 3855-3864.
- Office for National Statistics (a). (2016) *Internet access households and individuals: 2016, Figure 13*. Available at: <https://www.ons.gov.uk/peoplepopulationandcommunity/householdcharacteristics/homeinternet-in-online-shopping> (Accessed: 11 August 2017)
- Office for National Statistics (b). (2016) *Statistical bulletin: Family spending in the UK: financial year ending March 2016, Figure 10*. Available at: <https://www.ons.gov.uk/peoplepopulationandcommunity/personalandhouseholdfinances/expo> (Accessed: 11 August 2017)
- Welsh Assembly Government (2013). *Welsh language Technology and Digital Media Action Plan (2013)*. Cardiff, Welsh Language Commissioner. Available at: <http://wales.gov.uk/docs/dcells/publications/230513-action-plan-en.pdf> (Accessed: 3 August 2017)
- Welsh Assembly Government (2017). *Cymraeg 2050: A million Welsh speakers* Cardiff, Welsh Language Commissioner. Available at: <http://gov.wales/topics/welshlanguage/welsh-language-strategy-and-policies/cymraeg-2050-welsh-language-strategy/?lang=en> (Accessed: 3 August 2017)
- Welsh Assembly Government (2000). *A Culture in Common*. Cardiff, Welsh Language Commissioner. Available at: www.assembly.wales/39FFF269000BAC180000299400000000.pdf (accessed: 4 August 2017)
- Welsh Assembly Government (2015). *National Survey for Wales, 201314: Welsh Language Use Survey (2015)*. Cardiff, Welsh Language Commissioner. available at: www.gov.wales/docs/statistics/2015/150129-welsh-language-use-survey-en.pdf (Accessed: 4 August 2017)
- Welsh Assembly Government and Welsh Language Commissioner (2015). *National Survey for Wales, 201314: Welsh Language*

Use Survey (2015). Cardiff, Welsh Language Commissioner. www.gov.wales/docs/statistics/2015/150129-welsh-language-use-survey-en.pdf (Accessed: 4 August 2017)

Welsh Assembly Government and Welsh Language Commissioner (2015). *Welsh language use in Wales 201315*. Cardiff, Welsh Language Commissioner. Available at: <http://gov.wales/statistics-and-research/Welsh-language-use-survey/?lang=en> (Accessed: 4 August 2017)

Williams, D., Cunliffe D., Tudhope, D. and Vlachidis, A. (2017). Welsh Natural Language Toolkit. Available at <https://sourceforge.net/projects/wnlt-project/>

Wyburn, J. and Hayward, J. (2008). The future of bilingualism: an application of the Baggs and Freedman model. *Journal of Mathematical Sociology* 32, 267-284.

Wyburn, J. and Hayward, J. (2009). OR and language planning: modeling the interaction between unilingual and bilingual populations. *Journal of the Operational Research Society* 60, 626-636.