

## **User's Manual for the Lifetime and Residual Risk Calculator**

The calculator is based on the following publication:

Thornton, D., Hanson, R. K., Kelley, S. M. & Mundt, J. C. (2019). Estimating lifetime and residual risk for individuals who remain sexual offense free in the community: Practical applications. *Sexual Abuse*. Online first publication. doi:10.1177/1079063219871573

This calculator is provided free of charge on an “as is” basis. No warrantee or liability is expressed or implied regarding the use of this calculator. The calculator is free of any known defects to the best of the authors' knowledge. Users are responsible for understanding the statistical methods applied and verification of results, if required.

The views expressed are those of the authors and not necessarily those of the Wisconsin Department of Health Services.

## Introduction

This document describes the use of a calculator, implemented as a Microsoft Excel workbook, to project 20-year risk for sexual recidivism for individuals with a known history of sexual offending. The projections are based on the discrete time survival analyses as applied by Thornton, Hanson, Kelley, and Mundt (2019). The underlying research on which this is based is described in Hanson, Harris, Letourneau, Helmus, and Thornton (2018).

The model takes account of three factors determining risk for future sexual offending:

1. Known short-term risk based on risk factors present at the time of release from the index sexual offense;
2. Gradual reduction in risk over time for individuals who remain sexual offense free while living in the community;
3. Increase in risk for individuals who reoffend non-sexually after release from the sentence served for their index sex offense.

In principle, a statistically sophisticated evaluator could use the equations provided by Hanson et al. (2018) to produce their own 20-year risk projections, but the process is both cumbersome and beyond the competence of many evaluators. In light of this consideration, an Excel-based calculator was developed to permit evaluators to input relevant information pertinent to a specific case. The calculator automatically performs the appropriate calculations based on the previously published analyses.

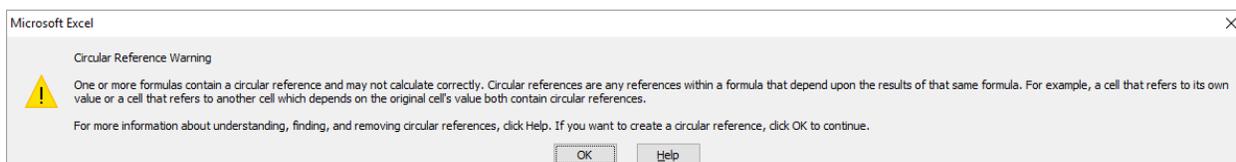
A person using the calculator chooses the short-term risk estimate to extrapolate from. This may be derived from any credible actuarial instrument. The calculator then determines what 20-year sexual recidivism rate is to be expected given that short-term rate.

Three main uses have been identified for the calculator.

1. For individuals about to be released to the community following their index sexual offense, it can project expected 20-year sexual recidivism rates based on a known short-term sexual recidivism rate (e.g., extrapolating from a known 5-year rate to a 20-year rate).
2. For individuals who were released following their index sex offense and who have now been in the community for a number of years without further offending, it can project expected 20-year sexual recidivism rates based on the short-term sexual recidivism risk that applied at the point of release from the index sex offense and the number of years they have been free in the community without reoffending.
3. For individuals who were released following their index sex offense and who have now been in the community for a number of years without further sexual offending but have come to attention because of a new non-sexual offense, it can project expected 20-year sexual recidivism rates based on the short-term sexual recidivism risk that applied at the point of release from the index sex offense, the number of years they have been free in the community without sexual reoffending, and the commission of a new non-sexual offense.

## Calculator Instructions

1. The calculator can be downloaded at <http://www.static99.org/...>
2. The calculator will download as an Excel Macro-Enabled Workbook (.xlsm). The workbook should function properly on Microsoft Windows implementations of Microsoft Excel 2010 and later versions.
  - a. Earlier versions of Excel may not support all functions and formatting.
  - b. Proper functioning requires an Excel configuration that supports iterative calculations. If an error or warning message concerning ‘Circular References’ is observed upon opening the workbook, such as the one below, the Excel configuration on your computer will need to be changed



- i. Configuration can be set/checked under:
      - File → Options → Formulas
      - Check “Enable iterative calculation”
      - Set “Maximum iterations:” to 10,000
      - Set “Maximum Change:” to 0.0001
    - c. Compatibility with other operating systems has not been tested.
3. The workbook is composed of 5 ‘worksheets’ or ‘tabs.’
  - [1] “Calculator” [2] “Get\_HR” [3] “Time Accounting” [4] “GHR\_RecidRates” [5] “GHR\_NS\_RecidRates”
  - a. **As a user, you will only interact with the “Calculator” worksheet/tab.** The other tabs perform critical functions that determine the information presented on the “Calculator” tab. They have been locked and password protected to prevent modification. Details about worksheet functions and data are provided below in the description of [How the calculator works](#).
  - b. User input is limited to cells that are highlighted in bright yellow. All other cells are locked and cannot be modified.
4. **IMPORTANT:** At the start of each case, **double click on the grey RESET button!** Clicking the RESET between cases, as well as at the start of each session, is recommended. Anytime the calculator does not appear to be functioning properly, it is prudent to start with a fresh workbook.
  - a. The RESET button should clear out any/all data that exists on the worksheet.
  - b. **Failure to RESET the worksheet prior to each new case can produce errors. Persistence of previously entered information may be hidden from the user’s view and could affect output.**
  - c. **Always start use of the calculator for a particular case with a blank worksheet!**
5. First, input the date of release from the offender’s index sex offense in cell E3.

- a. The field will accept any valid date after 1/1/1900, including potential release dates in the future. By default, the workbook uses a date format of MM/DD/YYYY; it will support other date formats if properly configured in the Microsoft Excel preference options.
  - b. The date entered defines the end date of “Year 0” (shown in cell I5).
6. Enter:
- a. Recidivism Risk in cell B5 (e.g., 32.5 percent = ‘32.5’ not 0.325). Input may be any real number between 0 and 100. Multiple decimal places may be specified, however only the first decimal place (rounded) will be displayed.
  - b. Follow-up time frame in cell B6 (Years). Must be a whole number between 1 and 20. When the follow-up time for a case is not a whole number, we recommend that it is rounded down. For example, for an individual with a follow-up time of 3 years, 10 months, a follow-up time of 3 would be entered. The calculations are based on complete years of follow-up time.
  - c. The assessment instrument(s) used to estimate an expected recidivism risk at a specified follow-up period is determined by the evaluator. Many may choose to use Static-99R scores referenced to the predicted 5- or 10-year recidivism rates published in the most recent version of the STATIC Evaluators’ Workbook (e.g., Phenix, Helmus, & Hanson, 2016 or subsequent versions). Recidivism estimates may be referenced to the Routine or High Risk/High Needs samples. Other evaluators may choose to use a combination of instruments, such as the estimated sexual recidivism rates from the combination of Static-99R and STABLE-2007 scores or the Static-99R and Violence Risk Assessment – Sexual Offense version (VRS-SO) scores.
  - d. Examples:
    - i. Static-99R = 2, Routine sample, 5-year estimate:  
Recidivism Risk? (B5) = 5.6; At what year? (B6) = 5
    - ii. Static-99R = 5, Routine sample, 5-year estimate:  
Recidivism Risk? (B5) = 15.2; At what year? (B6) = 5
    - iii. Static-99R = 5, HRHN sample, 5-year estimate:  
Recidivism Risk? (B5) = 21.2; At what year? (B6) = 5
    - iv. Static-99R = 5, HRHN sample, 10-year estimate:  
Recidivism Risk? (B5) = 32.1; At what year? (B6) = 10
    - v. Static-99R = 3, STABLE-2007 = 8, 5-year estimate:  
Recidivism Risk? (B5) = 7.5; At what year? (B6) = 5
    - vi. Static-99R = 6, VRS-SO pre-Tx dynamic score of 37, and 3.5 points of treatment-related change, 10-year estimate:  
Recidivism Risk? (B5) = 38.1; At what year? (B6) = 10
  - e. Overall risk and residual risk after time free in the community with re-offending sexually will not be computed without a predicted recidivism rate and follow-up year in cells B5 and B6.
  - f. Overall lifetime risk and residual risk will be computed and displayed in Column J when sufficient information is provided to apply the appropriate discrete time survival analysis.
7. Indicate whether any **convictions** for a nonsexual offense occurred after the offender’s index offense release date while the offender was residing in the community (cell E7).

The nonsexual offense must be a criminal offense (not a violation of conditions) that is sufficiently serious that the individual could potentially receive jail time or community supervision as a result. Offenses that result in citations and would not result in possible jail time are not counted here (see the 2016 Static-99R Coding Manual for definitions of conviction; Phenix et al., 2017). Use of the drop-down data choices by clicking on the ▼ button that appears when entering E7 is recommended. You may also type in “Yes” or “No” but text input is case sensitive, so entries of “yes” or “NO” are not valid.

- a. An entry of “No” will apply a model that reduces the log-odds of risk for recidivating by .130 units for each year free in the community without reoffending sexually (Model 5 of Table 4 in Hanson, et al., 2018).
  - b. An entry of “Yes” will apply a model that reduces the log-odds of risk for recidivating by .135 units for each year free in the community without reoffending sexually. The log-odds of risk for recidivating sexually will be increased by .440 units as of the year of the nonsexual offense (Model 6 of Table 5 in Hanson, et al., 2018).
    - i. Entering “Yes” in cell E7 will ask for the date of the first nonsexual offense to be entered in call E9. The log-odds increase in risk for sexual reoffending will be applied beginning in the year of the first nonsexual offense.
    - ii. The date of a reported nonsexual offense must be after the date of release for the index offense (cell E3) and before the current date.
8. Indicate whether or not the offender has been removed from the community for any period of time since release from their index offense (cell E11). Removal of the individual from the community for any reason (e.g., revocation of probation, violation of supervision rules, jail or prison time for nonsexual offenses, etc.), means that the offender was not in the community, and thus not at risk to reoffend sexually. They cannot be given credit for refraining from reoffending while not in the community, so these periods must be removed from their accrual of time free in the community desisting from reoffending.
- a. Use of the drop-down data choices by clicking on the ▼ button that appears when entering a response in E11 is recommended. You may also type in “Yes” or “No” but text input is case sensitive, so entries of “yes” or “NO” are not valid.
  - b. An entry of “No” will calculate the end of each year that is free from sexual re-offense for years 1 – 20 (Column H) as a continuous period starting on the date of release from the index offense (Column I). If the date of release was less than 20 years prior to the current date, the calculator will project the end of some years into the future.
  - c. An entry of “Yes” in E11 will require you to indicate the number of times the individual has been removed from the community in cell E13. Cell E13 will accept any whole number greater than 0.
9. Entering a valid number into E13 will produce a formatted table in Columns L – N to identify dates and duration of each removal from the community. The end dates for complete years in the community remaining free of a sexual re-offense cannot be determined until the table is completed.

- a. The calculator will accept any number of removals from the community greater than 0; however, the table in columns L – N will only allow identification of a maximum of 10 such events.
    - i. If the offender was removed from the community on more than 10 occasions, then the durations of all events after the 10<sup>th</sup> event should be summed and added to the duration of the 10<sup>th</sup> event.
  - b. For each event/occasion that the offender was removed from the community, the date they were removed (Column M) and the duration of the removal in days (Column N) should be identified.
    - i. Two calculators are provided to assist in calculating the duration of events in days.
      1. Entry of two dates in cells P5 and R5 will display the duration in days between the dates in cell S5. The date in cell R5 must be after the date in P5.
      2. Cells P8 – R8 will accept whole number inputs for durations of years, months, and weeks. The durations across the different time units summed, in days, and displayed in cell S8. Thus, an entry of 1 year and 6 months will display the same duration in days as an entry of 18 months, or 78 weeks.
  - c. Dates of removal from the community events must be after the index offense release date and must be after the re-entry dates of any prior removal events (Event removal date + removal duration days).
  - d. Valid entries for the duration of community removal events must be whole numbers greater to or equal to zero.
10. Upon completion of all required inputs, the dates of the end of each full year of being free in the community without reoffending sexually should be display in rows 6 – 25 of column I. The row for any year that ended more than one year prior to the current date is blacked out. Required inputs include:
- a. E3: Release date from index offense
  - b. E7: Negative or Positive for conviction of nonsexual offense after release
    - i. E9: If E7 is positive, date of first nonsexual offense conviction after release
  - c. E9: Negative or Positive for periods of removal from community after release
    - i. E13: If E9 is positive, number of times the offender was removed from the community
    - ii. Dates of removals and duration in days for each occasion (Columns M and N, Rows 4 – 13)
11. The residual lifetime risk as of the current date is shown in J27.
- a. Computation of the risk as of the current date is interpolated linearly using the percentage of the year completed with an ending date after the current date.

### **How the calculator works**

The calculator for estimating reductions in recidivism risk based on time free in the community without reoffending is founded on statistical methods used for life table survival analysis (Singer & Willet, 2003, Chapter 10). The approach estimates recidivism rates for discrete periods of time based on the proportion of individuals who reoffend during a given interval, divided by the total number of individuals “at risk” for reoffending during that interval. This “hazard rate” (number reoffending/total persons at risk to reoffend) is used to estimate how many individuals are removed from the population of interest during a particular interval (i.e., how many recidivate in a given year) and how many “survive” to the next discrete time interval.

Several basic assumptions are made about how risk for recidivating changes over time as time free in the community without reoffending sexually accumulates. These include:

1. The log odds of the hazard rate to reoffend in any given year for individuals who do not have a nonsexual offense after release from their index offense is reduced by .130 log units for each year they remain in the free in the community without sexually reoffending. This estimate is taken from analyses described and reported in Hanson et al., 2018, Table 4, Model 5.
2. The log odds of the hazard rate to sexually reoffend in any given year for individuals with a nonsexual offense after release from their index offense is increased by .440 log units the year in which the first nonsexual offense occurs. Their yearly reduction in risk for sexual reoffending is reduced by .135 log units for each year they remain in the community offense free. These estimates are taken from analyses reported in Hanson et al., 2018, Table 5, Model 6a.
3. The relative reduction in risk for reoffending associated with time free in the community without reoffending is constant across all initial levels of risk.
4. The hazard for reoffending after remaining free in the community for 20 years without reoffending is negligible. For purposes of the calculator, it was set to 0 after 20 sexual offense free years in the community.

### **Sexual offense free years in the community**

The first function required of the calculator is to identify specific discrete time intervals of one year, during which the individual remained free in the community without reoffending sexually. Any periods that an individual was removed from the community cannot be considered in the reduction of risk since such periods cannot be considered “at risk” for reoffending. This is the purpose for identifying whether the individual was removed from the community or not (cell E11), and if so, how many times (cell E13), and the initiation and duration of each removal from the community (cells M4 – M13; N4 – N13).

This function is performed in the “Time Accounting” tab/worksheet, which can be viewed for verification if desired. All cells in this worksheet have been locked to prevent modification.

An individual is considered to have returned to the community (and thereby becomes at risk to potentially reoffend) as of the index offense release date identified (cell E3). Time free in the community accumulates until the start of the first removal event (cell M4). Re-entry of the individual back into the community is computed from the removal date identified plus the number of days removed from the community (cell N4). Each period of time the individual is in the community and at risk to potentially reoffend are shown in columns A and B, rows 2 – 12 of

the “Time Accounting” tab/worksheet. Days in the community for each interval are displayed in column C, the cumulative days free in the community are shown in column D, and the number of years accounted for since the initial release date presented in column E. These data are used to compute end dates for one-year intervals (365.25 days), removing any time that the individual was not in the community – and thereby not at risk to reoffend. Thus, the end date of the first year “free in the community” for a person who was incarcerated for one month prior to completing a full year in the community would be 13 months after their initial release date.

The dates identified as the end of each complete year, and the number of days remaining to be accounted for in future years, are shown in rows 2 – 12 of columns J through AV of the “Time Accounting” tab/worksheet. The final timeline that computes the end dates for 20 complete years, beginning at the release date from the index offense and removing any time the individual was not free in the community, are shown in row 22. The calculations do allow for year-end dates to be projected into the future. These dates are used to populate the ‘Year End Date’ of column I of the “Calculator” tab/worksheet. NOTE: The row for any ‘Year End Date’ that is more than 1 year prior to the current date is blackened out on the “Calculator” tab/worksheet to reduce the potential for confusion in reading residual risk.

### **Estimating the 20-year recidivism risk and risk reduction associated with the passage of sexual offense free time in the community**

The overall 20-year recidivism risk projection is displayed in cell J5 of the Calculator tab/worksheet. These values, and the reduction of risk associated with time free in the community without reoffending sexually, are derived by calculations performed in the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tab/worksheets. Like the “Time Accounting” tab/worksheet, all cells in both of these worksheets have been locked and password protected to prevent modification. The formulas underlying the procedures and calculations conducted are explained below for users interested in understanding the mechanisms underlying discrete time survival analysis in greater depth.

#### Hazard rate models of predicted recidivism

The approach to modeling recidivism risk applied in the present context is based on life table survival analysis. This method uses a specified *hazard rate* – the number of individuals reoffending/total persons at risk to reoffend over a specified period of time (e.g., one year) – to model how many individuals are removed from the population during a particular interval. This method estimates how many individuals recidivate in a given year, and how many “survive” to the next interval/year and remain at risk to potentially reoffend sexually the following year.

Recidivism rates (“Calculator” tab, cell B5) after a specified number of years following release (“Calculator” tab, cell B6) may be estimated from any source. For example, the 2015 Static-99R and Static-2002R Evaluators’ Workbook (Phenix et al., 2016) provides predicted 5-year recidivism rates for individuals with Static-99R scores from -3 to 10 referenced to the Routine sample, and Static-99R scores from -1 to 10 referenced to the High Risk/High Need (HRHN) sample. Individuals with a Static-99R score of 5 who are most reflective of Routine sex offender samples have a predicted recidivism risk of 15.2 percent at 5 years; individuals with the same Static-99R score but more similar to HRHN samples would have predicted recidivism risks of 21.2 and 32.1 percent after 5 and 10 years, respectively. Individuals with Static-99R scores of 7 with characteristics similar to Routine samples should predict a 5-year sexual recidivism rate of

27.2%. These would be the values entered in cells B5 and B6 of the “Calculator” tab/worksheet. **NOTE: The value entered into the ‘Recidivism Risk?’ field (cell B5) must a positive number between 0 and 100. Do not include the “%” sign after the numeric value.** Decimals are acceptable for the expected recidivism rate; however, only the first digit (rounded) will be displayed on the calculator. **The value entered into the ‘At what year?’ field (cell B6) must a whole number between 1 and 20.**

These models, based on yearly hazard rates of potential recidivists who do recidivate in a given year, must take into account risk reductions associated with accumulated time free in the community without reoffending sexually. Prior analyses demonstrate clear reductions of risk associated with time free in the community without reoffending (Hanson, Harris, Helmus, & Thornton, 2014). More recent analyses quantified the reduction of risk for each year free in the community without reoffending as  $-.130$  log units per year (Model 5, Hanson et al., 2018). Thus, an accurate model of recidivism risk based on annual hazard rates must produce projected recidivism rates that (1) align with established norms and (2) reflect reductions in risk with the passage of time free in the community without reoffending. An additional factor complicating application of these models is the known, independent contribution of nonsexual offending for increasing an individual’s risk for reoffending sexually by  $.440$  log units (Model 6, Hanson et al., 2018).

These factors are taken into account and the appropriate survival model applied in the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets using an initial hazard rate that is reiteratively computed in the “Get\_HR” and “GHR\_RecidRates” tabs/worksheets. The user-specified recidivism risk at a particular follow-up interval, entered into cells B5 and B6 of the “Calculator” tab/worksheet, is used to drive reiterative calculations of a hazard ratio for the initial year. A detailed description of the calculations going into the projected 20-year risk for sexual recidivism for a specific individual, and the risk reduction associated with the passage of offense free time in the community is presented below. We make an explicit assumption that the risk for reoffending sexually of an individual with a history of sexual offending is negligible after 20 years in the community and remaining sexually offense free. We opted to use Model 5 of Hanson, et al. (2017) to derive the initial year hazard ratio because of the larger sample size used to estimate model parameters ( $n = 7,225$ ) compared to the sample size used to estimate model parameters of Model 6 ( $n = 4,078$ ).

Consider an individual with a Static-99R score of 5 referenced to the Routine sample norms. Their predicted recidivism risk would be 15.2 percent at 5 years; these values would be entered into cells B5 and B6 of the “Calculator” tab/worksheet. These values are also written to cells C2 and C3 of the “Get\_HR” tab/worksheet. The recidivism risk to be modelled (15.2 percent) is written to cells H2 to H21 of the “GHR\_RecidRates” tab/worksheet.

The hazard ratio (cell C6 of the “Get\_HR” tab/worksheet) starts at an arbitrary value. It represents the initial hazard rate of the first year, or the “probability of an individual not surviving” the first year. It is the expected sexual recidivism rate of the first year. This value is written into cell D2 of the “GHR\_RecidRates” tab/worksheet (the value is shown in red). The log odds (or ‘logit’) of the starting hazard rate is calculated in C2 of the “GHR\_RecidRates” tab/worksheet. The probability of surviving the first year ( $1 - \text{the hazard rate}$ ) is computed in cell

E2, the cumulative survival rate to that point in time is calculated in cell F2, and the recidivism rate [ $100*(1 - \text{the cumulative survival})$ ] is computed in cell G2.

For each subsequent year the cumulative percentage of the population surviving the prior year (column F) is carried over to the following year in column B. The logit of the hazard rate for each subsequent year is reduced by .130 log units of the prior year to reflect the reduction in risk associated with being one year in the community without sexually reoffending (column C). The log odds of the hazard rate is converted back to a probability of reoffending for that year using the logistic linking function (column D), which is used to calculate probability of individuals entering that year to ‘survive’ the year without sexually reoffending (column E). The cumulative survival rate as of the end of that year (column F) is calculated by multiplying the percentage of the population entering the year (column B) by the probability of surviving that year without sexually reoffending (column E). The cumulative recidivism rate to that time point (column G) is equal to  $100*[1 - \text{the cumulative survival rate (column F)}]$ .

The mathematical process for calculating the cumulative survival and recidivism rates each year is:

1. Bring the proportion of the population “surviving” a given year (column F) to the start of the following year (those remaining at risk for reoffending during that year in column B).
2. Link the hazard rate for a given year to the prior year’s hazard rate in logit units (column C) and use the logistic function to compute that year’s hazard rate (column D).
3. Calculate the probability of remaining offense free based on that year’s hazard rate (column E).
4. Project the cumulative proportion surviving through the end of that year (column F), based on the proportion of the population entering that year times the probability of remaining offense free during the year.
5. Finally, compute the total recidivism rate as of the end of that year (column G), based on the cumulative survival rate through the end of that year.

As a simple example, the first 5 years of a survival function starting with an initial hazard ratio of .0100 (1.0 percent first year re-offense rate) is shown in the table below.

| Year | p at risk | logit hazard | Hazard rate | p surviving | cumulative surv | recidivism rate |
|------|-----------|--------------|-------------|-------------|-----------------|-----------------|
| 1    | 1.000     | -4.5951      | 0.0100      | 0.9900      | 0.9900          | 1.000           |
| 2    | 0.990     | -4.7251      | 0.0088      | 0.9912      | 0.9813          | 1.870           |
| 3    | 0.981     | -4.8551      | 0.0077      | 0.9923      | 0.9737          | 2.629           |
| 4    | 0.974     | -4.9851      | 0.0068      | 0.9932      | 0.9671          | 3.290           |
| 5    | 0.9671    | -5.1151      | 0.0060      | 0.9940      | 0.9613          | 3.867           |

The probability of surviving the first year would be 99.00 percent, which would be the proportion of the population entering the second year still at risk of reoffending. To account for risk reduction from the first year’s hazard rate – reflecting one year in the community without reoffending sexually – .130 log units is subtracted from the log odds of the first year’s hazard rate. Thus,  $\{\ln[.01/(1-.01)]\} = -4.5951$ , minus .130 which equals -4.7251 for a log odds of the second year’s hazard rate. This converts to a hazard rate of 0.88 percent of individuals entering the second year expected to recidivate during that year. Thus, 99.12% of the 99.00% of the population entering the second year ( $.9912* .9900 = .9813$ , or 98.13%) would be expected to

survive to the start of year 3. A new hazard rate reflecting two years free in the community without sexually reoffending (an additional reduction of 0.130 log units from the second year's hazard rate) would then be calculated and applied. This process would continue through year 20 to estimate the lifetime risk for recidivating sexually (the table above is truncated to 5 years).

Now, consider the individual with a Static-99R score of 5, referenced to the Routine sample norms, with a predicted recidivism risk of 15.2 percent at 5 years. The table above with an initial hazard of .0100 produces a 5-year expected recidivism rate of 3.867 percent. Comparing this value to an expected recidivism rate of 15.2 percent in cells H2 to H21 of the “GHR\_RecidRates” tab/worksheet produces an underestimation of 11.3 percent (calculated in column I of the “GHR\_RecidRates” tab/worksheet at the row corresponding to the follow-up year at which the modelled recidivism rate is expected). This error is used by the “Get\_HR” tab/worksheet. If the error exceeds a set error tolerance ( $\pm 0.1\%$ ), the initial year hazard rate is reiteratively incremented or decremented until the cumulative recidivism rate produced by the survival model in the “GHR\_RecidRates” tab/worksheet at the follow-up year specified is within the allowable error tolerance.

Starting with an initial year hazard rate of .0100, entering an expected 5-year recidivism rate of 15.2 percent into the calculator results in a first year hazard rate of  $\sim .0410$  and a 5-year expected recidivism of 15.185 percent (see table below). *Note: The computational process of reiteratively incrementing and decrementing the initial hazard rates produces minor variability in the third or fourth decimal places of final values due to the error tolerance allowed in fitting the survival model to specified recidivism rates at identified follow-up years.*

| Year | p at risk | logit hazard | Hazard rate | p surviving | cumulative surv | recidivism rate |
|------|-----------|--------------|-------------|-------------|-----------------|-----------------|
| 1    | 1         | -3.1532      | 0.0410      | 0.9590      | 0.9590          | 4.101           |
| 2    | 0.9590    | -3.2832      | 0.0362      | 0.9638      | 0.9243          | 7.568           |
| 3    | 0.9243    | -3.4132      | 0.0319      | 0.9681      | 0.8948          | 10.515          |
| 4    | 0.8948    | -3.5432      | 0.0281      | 0.9719      | 0.8697          | 13.031          |
| 5    | 0.8697    | -3.6732      | 0.0248      | 0.9752      | 0.8481          | 15.185          |

Based on the explicit assumption that the residual risk for reoffending sexually is negligible for an individual with a history of sexual offending after 20 years in the community without re-offending sexually, the projected 20-year recidivism rate (cell G21 of the “GHR\_RecidRates” tab/worksheet) is used as the overall life time risk at the time of release. This value is equivalent to the 1 minus the cumulative survival rate of a population ( $S_T$ ). The cumulative survival rate is also the product of yearly survival rates across all years at risk:  $S_T = \prod_{year=1}^t (1 - h_t)$ , where  $h_t$  is the annual survival rate at each year. These cumulative survival rates are computed in columns J to AC of the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets.

Specifically, J2 through J21 calculates the cumulative survival rate across years 1 through 20, or  $\prod_1^{20} (1 - h_t)$ ;  $h_t$  is the survival rate for each year (shown in column E). This survival rate is equivalent to the cumulative survival rate across 20 years (shown in cells F21 and J21), and is used to compute the 20-year (lifetime) survival rate shown in G21).

Residual risks of reoffending among individuals who do not reoffend during the 1<sup>st</sup>, 2<sup>nd</sup>, ... 19<sup>th</sup> year of being free in the community are correspondingly calculated in columns K through AC.

For example, the cumulative survival rate of individuals who do not reoffend in the 1<sup>st</sup> year is calculated in column K. Cells K3 through K21 compute  $\prod_2^{20}(1 - h_t)$ , ignoring the hazard associated with year 1 since it is not relevant to individuals who survive the first year without reoffending. Similarly, the cumulative survival rates of individuals who successfully enter years 3 through 19 are computed in columns L through AC [ $\prod_3^{20}(1 - h_t)$ ,  $\prod_4^{20}(1 - h_t)$ , ...  $\prod_{19}^{20}(1 - h_t)$ ]. These calculations represent the residual risks remaining for individuals entering each subsequent follow-up year through year 19 under the assumption that the residual risk for individuals entering year 20 without sexually reoffending is 0.

Subtracting the cumulative survival rate across all 20 years (cell J21 of the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets) from 1 provides the lifetime risk for an individual, which is copied to cell J5 of the “Calculator” tab/worksheet. Subtracting the cumulative survival rate across years 2-20 years (cell K21 of the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets) from 1 provides the residual risk of an individual surviving the first year without reoffending and entering the second year. This value is copied to cell J6 of the “Calculator” tab/worksheet. Subsequent values computed in cells L21 – AC21 of the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets, provide the cumulative survival rates for individuals free in the community entering years 3 through 19 without sexually reoffending. Subtracting 1 from those values provides the residual risk remaining at the start of each new year, shown in rows 7 through 24 of column J in the “Calculator” tab/workbook (These values are computed in column AE of the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets and copied to the “Calculator” tab/worksheet.)

#### Hazard rate models of predicted recidivism among individuals convicted of nonsexual offenses

The “GHR\_NS\_RecidRates” tab/worksheet is used to model lifetime and residual risk of individuals with a history of sexual offending who are convicted of a nonsexual offense after release from their index sexual offense. The layout and functionality of the tab/worksheet is very similar to the “GHR\_RecidRates” tab/worksheet described above, with a few critical differences.

The initial annual hazard ratio, reiteratively derived from the specified recidivism rate and follow-up year entered into cells B5 and B6 of the “Calculator” tab/worksheet, is computed in the same fashion described above, using the “Get\_HR” and “GHR\_RecidRates” tabs/worksheets. This choice reflects the larger samples size used to estimate model parameters in Model 5 of Hanson et al. (2018). The hazard ratio derived in the “Get\_HR” tab/worksheet is then written to cell A2 of the “GHR\_NS\_RecidRates” tab/worksheet (shown in red), rather than cell D2 as is done in the “GHR\_RecidRates” tab/worksheet. This allows the actual hazard rate for the first year to be increased (by .440 log units) or decreased (by .135 log units) depending on whether the nonsexual offense occurred before the end of the first year. These values reflect the parameter estimates of Model 6 in Hanson et al. (2018) that take increased risk for sexually reoffending among individuals with a history of reoffending who are convicted of a nonsexual offense after release from their index sexual offenses into account.

The 0.440 log unit hazard rate increase for sexually reoffending is applied only once, as of the year that a nonsexual conviction occurred (identified by the user in cell E9 of the “Calculator” tab/worksheet). The hazard rates (column D) for all other years in free community without sexually reoffending are decremented by 0.135 log units. The risk reductions reflected in annual decrements of hazard rates are realized for years prior to the year of a nonsexual conviction, as

well as for the years following the nonsexual conviction. The actual probability of surviving a year free in the community without sexually recidivating – prior to the year of conviction for a nonsexual offense – is 1.0, however. That is, anyone surviving in the community long enough to be convicted of a nonsexual offense must have refrained from sexually recidivating to that point or they would have been removed from the population as a sexual recidivist prior to the nonsexual offense conviction. Thus, prior to the year of a nonsexual offense conviction, the probability of surviving each year (column E) is set to 1.0, despite the modelled hazard rates (columns C and D). The cumulative survival rate for such years (column F) is, by definition, 100% with realized cumulative sexual recidivism rates (column G) of 0%. Realized sexual recidivism risk following conviction for a nonsexual offense begins as of the year the nonsexual offense conviction occurs (and the hazard rate is incremented 0.440 log units), and accumulates through year 20 after release from the index sexual offense (cell E3 of the “Calculator” tab/worksheet).

The computational processes for deriving the cumulative survival rates across years 1 through 20, shown in columns J through AC of the “GHR\_NS\_RecidRates” tab/workbook, are identical to those described above for individuals without a post-release nonsexual offense conviction.

#### Residual Risk as of Current Date

Row 27 of the “Calculator” tab/worksheet shows the current date (cell H27) and the residual lifetime risk as of today (cell J27). This value is interpolated linearly from the values presented above in cells J5 – J25. If the current date is toward the beginning of the year in which it falls, the value will be closest to the ending value of the prior year. If it is toward the end of the year yet to be completed, the value will be closer to the end of the year value.

#### Extrapolation for Lifetime Risk less than 20 years

Some evaluators may wish to extrapolate lifetime risk for a time period less than 20 years. One approach to doing so would be to compute the cumulative survival rate across years 1 through X, or  $\prod_1^X (1 - h_t)$ , where  $h_t$  is the survival rate for each year and X is the number of years the evaluator wishes to extrapolate to. These computations are completed in the workbook (columns AF to AX in the “GHR\_RecidRates” and “GHR\_NS\_RecidRates” tabs/worksheets), and could be used by evaluators with sufficient knowledge of discrete time survival methods to explain clearly why computed lifetime risks vary as a function of the extrapolation period chosen.

A simpler method for extrapolating lifetime and residual risk for periods less than 20 years is also available. If an evaluator wishes to extrapolate a discrete number of years X (less than 20), then they anticipate re-offense risk for that individual to be 0 at the end of X years. We recommend simply subtracting the expected residual risk shown in column J of the “Calculator” tab/worksheet at the end of X years (column H) from the expected residual lifetime risks for all years prior to X (removing the residual risk after year X that is never expected to be incurred).

For example, an individual with a Static-99R score of 5 referenced to the HRHN sample has an expected 10-year recidivism risk of 32.1 percent. Such an individual would have a 39 percent lifetime (20-year) risk. An evaluator wishing to extrapolate to 15 years, rather than 20, would note that the residual risk after 15 years was 3.6 percent. Since the 3.6 percent residual risk at 15 years would never be realized by an individual extrapolation to only 15 years, this value (3.6 %) could be subtracted from all residual risk estimates above it.

## References

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