



## Calculation of Severity in Accidental Fires in Dwellings

It became apparent that there was a need to quantify the severity in accidental fires in dwellings as currently there is nothing to distinguish between a severe house fire resulting in a fatality and a grill pan extinguished prior to arrival.

A methodology has therefore been developed in order to determine the severity of such fires, the work outlined explains the pilot scheme and subsequent testing.

It was decided that the severity of accidental dwelling fires could be determined under three broad categories: People, Property and Resources. The information within these sections was retrieved using the Incident Recording System (IRS) which is a national brigade recording system. In order to keep the calculations relatively simple several key fields were identified within each category.

In order to keep the formula for scoring fire severity straightforward and easy to understand it was decided that each category would score a figure between 1 and 5. This scale corresponds to other rating scales used within Fife Fire and Rescue Service, namely the Mosaic Risk rating used for community safety purposes and the Risk rating calculated in the FSEC toolkit, another nationwide government tool for analysis, risk and mapping.

Three methods of calculating the scores per category were examined; use of an average, use of the modal figure and use of the highest figure. Tests were carried out on various incidents recorded since the inception of IRS and the simplest and most accurate form of calculation appeared to be to use the highest score from any field within the category. Using this method produced results consistent with those given manually on a scale of 1 to 5 when taking into account all the variables.

It was therefore decided that this method would be adopted for each category.

Category 1- People

The main areas of focus within the People section were numbers and extents of injury and harm to human life. This was categorised as Life Risk and took information from seven fields in the recording system, which can be seen below.

- Were there any fatalities
- Were there any serious injuries
- Were there any injuries requiring outpatient attention
- Was a precautionary check required
- Was first aid administered at the scene
- Were there any rescues

Each field was given a weighted score, with the heaviest emphasis being on the most serious of injuries and fatalities (see Fig. 1).

| <b>People</b>              | <b>1</b> | <b>2</b> | <b>3</b> | <b>4</b> | <b>5</b> | <b>&gt;5</b> |
|----------------------------|----------|----------|----------|----------|----------|--------------|
| <b>Fatalities</b>          | 5        | 5        | 5        | 5        | 5        | 5            |
| <b>Serious Injuries</b>    | 3        | 3        | 4        | 4        | 4        | 4            |
| <b>Outpatient Injuries</b> | 2        | 2        | 2        | 2        | 3        | 3            |
| <b>First Aid at Scene</b>  | 1        | 1        | 1        | 1        | 2        | 3            |
| <b>Precautionary Check</b> | 1        | 1        | 1        | 1        | 2        | 2            |
| <b>Rescues</b>             | 1        | 1        | 2        | 2        | 3        | 3            |

*Fig. 1*

The weighting placed on each field ensures that any incident involving a fatality will immediately be rated with the highest figure and other injuries are scored according to severity and number of instances. If no persons are involved then the People score will always remain at one, thus ensuring the lowest societal score is always at least one.

Category 2 – Property

As with the People category, various fields were identified that appeared to quantify the extent of damage to the property involved. These were as follows:

- Was property damage limited to smoke only
- What was the extent of the damage –
  - Limited to the source of ignition
  - Limited to the room of origin
  - Limited to the floor of origin
  - Affecting two or more floors
  - Affecting roof space only
  - Affecting roof space and other floor(s)
  - Affecting whole roof
  - Affecting whole building

Once again the scoring system for the fields was weighted in order that those incidents where the greatest extent of damage/fire spread were given a higher figure than those with only minimal damage (i.e. smoke damage only). In this way a small grill pan/pot burnt out or extinguished prior to brigade intervention will attract only the minimum score of 1 for this category. A larger fire which has taken hold and spread significantly would conversely be awarded a correspondingly higher score (see Fig. 2).

| <b>Property</b> | <b>Item 1st Ignited</b> | <b>Room of Origin</b> | <b>Roof space</b> | <b>Roof space and floor(s)</b> | <b>Whole roof</b> | <b>Floor of Origin</b> | <b>2 or more floors</b> | <b>Whole building</b> |
|-----------------|-------------------------|-----------------------|-------------------|--------------------------------|-------------------|------------------------|-------------------------|-----------------------|
| <b>Damage</b>   | 1                       | 2                     | 2                 | 3                              | 3                 | 3                      | 3                       | 4                     |

Fig. 2

In the case of property, the lowest score possible is 1; this ensures that the overall rating can only ever be as low as one, and then only when no people have been involved.

### Category 3 – Resources

Once again appropriate fields were identified as contributory information regarding the extent and severity of a fire. These included the number of resources deployed and method of extinction, the full field list can be seen below:

- Was fire fighting done prior to arrival
- Time at the scene
  - Up to 20 minutes
  - 20 to 60 minutes
  - 61 minutes to 140 minutes
  - 141 minutes to 300 minutes
  - Over 300 minutes
- Number of resources deployed (this comprises the number of appliances and officers in attendance at an incident) -
  - Up to and including 4
  - 5
  - 6 or more
- Method of extinguishing -
  - None
  - Removal from heat source/disconnect fuel supply
  - Other means
  - CO2/Dry powder/Foam
  - Burned out
  - Hose reel
  - Monitors/main branch jet

Using 5 years worth of historical data and, in order to decide upon a set of significant time bandings for scoring purposes, a decision was made to look at equal spacing between minimum and maximum, however, due to

the wide range of time scales between these; this approach was extremely skewed with almost all incidents falling into the lowest category (see Fig 3).

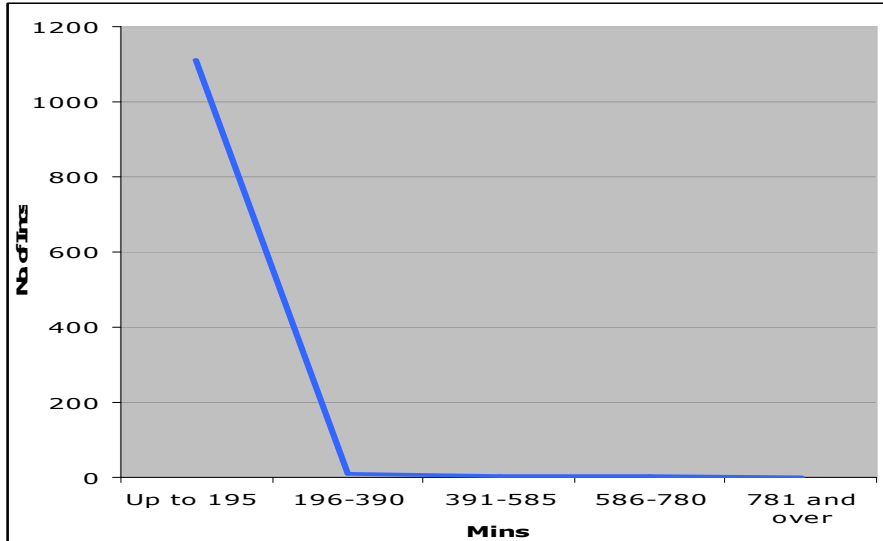


Fig 3

Therefore, after scrutiny of the time scales, random testing and sampling the decision was reached to use a simple geometric series to form the basis of the time bands, this is shown below –

$$X_n = ar^{(n-1)} \text{ where } r = 2, a = 20 \text{ and } n = 1$$

**a** represents the first term and **r** is the common ratio.

After further investigation, this series was combined to form the formula below which completes the basis of the time bands required.

$$a = 20 \text{ and } r = 2$$

$$x=0$$

$$\sum_{n=1} ar^{(n-1)}$$

The function when applied to the time bandings is illustrated on the graph overleaf (see Fig 4).

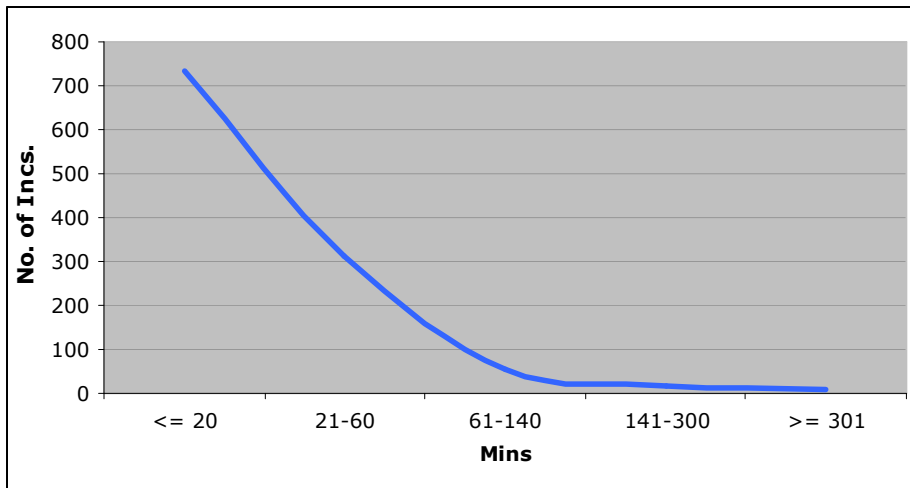


Fig 4

The bandings were then run against a series of tests with average timings for specific types of fire. The sets of tests were run over historical data and random samples were manually checked for relevance and accuracy. Operational staff examined the results and were able to verify the validity of the band scoring from experience.

The lowest score in this section is one, going right through to five for a fire requiring utilisation of multiple resources and having an attendance of more than 4 hours (see Fig. 5 & 6).

| Resources (1)           | None/No Fire fighting | Other means | Removal from heat source | Disc. Fuel supply | CO2/ Dry Powder /Foam | Burned out | Hose reel | Monitor /Main branch Jet |
|-------------------------|-----------------------|-------------|--------------------------|-------------------|-----------------------|------------|-----------|--------------------------|
| Action Prior to Arrival | 2                     | 1           |                          |                   |                       |            |           |                          |
| Fire fighting Action    | 0                     |             | 1                        | 1                 | 2                     | 0          | 3         | 4                        |

Fig. 5

| Resources (2)       | Up to 20 minutes | 21 to 60 minutes | 61 to 140 minutes | 141 to 300 minutes | Over 300 minutes | 0  | 1 | 2 | 3 | 4 | 5 | >5 |
|---------------------|------------------|------------------|-------------------|--------------------|------------------|----|---|---|---|---|---|----|
| Number of Resources |                  |                  |                   |                    |                  | 0* | 1 | 1 | 1 | 1 | 2 | 3  |
| Time at Scene       | 1                | 2                | 3                 | 4                  | 5                |    |   |   |   |   |   |    |

Fig. 6

\*Resources does not include Managers and it is possible that in some instances (e.g. a late fire call) only a Managers attendance is required

After consultation with representatives from both the Community Fire Safety sector and Operations it was decided that the rating methodology should be split into two distinct sections: Material Severity and Societal Severity.

Material Severity refers to the extent of the property damage and physical cost of the fire and uses the categories of Property and Resources in order

to prescribe a rating. This rating is as previously discussed on a scale of 1 to 5, however, in order to provide clarity and distinction between material and societal severity it was decided to adopt a colour rating corresponding to the figures. For example Red became 5 (the worst rating) and Green became 1 (the best rating).

|        |   |
|--------|---|
| Green  | 1 |
| Blue   | 2 |
| Yellow | 3 |
| Amber  | 4 |
| Red    | 5 |

Societal Severity refers to the life risk element involved in an incident and is based purely on the People category as outlined previously. In this section it was decided that the figures of 1 to 5 would remain as is and would thus form one half of the total severity rating.

In this way the incidents became rated with a combination of colours and numbers: Blue2, Red3, Amber1 and so on. The matrix overleaf shows the 25 possible combinations.

|        | 1 | 2 | 3 | 4 | 5 |
|--------|---|---|---|---|---|
| Red    | D | D | E | E | E |
| Amber  | C | C | D | D | E |
| Yellow | B | B | C | C | D |
| Blue   | A | B | B | C | C |
| Green  | A | A | A | B | B |

Each of the combinations was then assigned a character and colour to illustrate the overall severity which can then be translated using the following key.

|          |             |
|----------|-------------|
| <b>A</b> | Slight      |
| <b>B</b> | Moderate    |
| <b>C</b> | Serious     |
| <b>D</b> | Severe      |
| <b>E</b> | Very Severe |

These bandings were derived after substantial testing of historical incidents in order to ascertain the severity – both material and societal of each one in relation to the chosen categories.

In order to simplify the rating and facilitate mathematical calculations on the distribution and frequency of the incident occurrence it was decided that a numerical rating would be advantageous. For this reason the original scale of 1 to 5 was chosen leading to the simplified scale looking as below.

|          |             |
|----------|-------------|
| <b>1</b> | Slight      |
| <b>2</b> | Moderate    |
| <b>3</b> | Serious     |
| <b>4</b> | Severe      |
| <b>5</b> | Very Severe |

### Examples

After running historical data through the calculation system for the severity scale, it appeared that the scores allocated matched expectations. A description of typical fires from each severity rating is shown below.

#### **5 – Very Severe**

Fire affecting the whole building, it was extinguished using hose reels and led to damage affecting the whole building. Fire fighters were at the scene for 9.75 hours and this fire resulted in one fatality. The combined score in this case was Red5 indicating that the material severity had a factor of 5 and societal severity a factor of 5.

Fire leading to damage on the floor of origin, this was a late call and no fire fighting was required but the crews were at the scene for almost 4 hours. This incident also resulted in one fatality and in this instance the combined score was Amber5, with a societal factor of 5 and a material factor of 4.

These incidents were the only two from the time frame that fell into the 'Very Severe' rank of the scale.

#### **4 - Severe**

Fire affecting the whole building, extinguished by hose reel and resulting in damage to the whole building. Fire fighters were present at the scene for 4.25 hours but there were no persons involved. This incident attracted a combined score of Red1, made up of a material factor of 5 and a societal factor of 1.

Fire affecting the whole building, extinguished by hose reel and resulting in damage to the whole building. There were 7 appliances deployed to

this incident for the duration of 2.75 hours and one seriously injured casualty requiring hospitalisation was involved. This incident resulted in a combined score of Amber3, consisting of a material factor of 4 and a societal factor of 3.

Fire affecting 2 floors but not the whole building, extinguished by hose reel and resulting in damage to 2 floors. Fire fighters were at the scene for just under one hour and there were 7 appliances present. There were two people involved, one fatality and one person who needed hospital attention. This incident resulted in a combined score of Yellow5, made up of a material factor of 3 and a societal factor of 5.

### **3 – Serious**

Fire that was limited to the floor of origin and resulting in damage to the floor of origin, no fire fighting was required as the fire was extinguished prior to arrival and time at the scene was under half an hour. There was one fatality at this incident. The combined score for this incident was Blue5 which consisted of a material severity with a factor of 2 and a societal severity with a factor of 5.

Fire affecting the room of origin and causing damage to the floor of origin, fire fighters were on the scene for one hour and hose reels were deployed. There was one person involved in this incident and they required hospitalisation. This incident resulted in a combined score of Yellow3 indicating a material severity of 3 and a societal severity of 3.

Fire initially affecting the room of origin but resulting in damage to the whole building; fire fighters were in attendance for three hours and hose reels were deployed. The householders had attempted to extinguish the fire using a garden hose and no persons were hurt or injured. This incident resulted in a combined score of Amber1, made up of material severity with a factor of 4 and societal severity with a factor of 1.

### **2 – Moderate**

Fire limited to the room of origin and damage limited to the room of origin, fire fighting was done using hose reels and the crews were on the scene for half an hour. There was one person involved in the incident and they required a precautionary check up. This incident attracted a combined score of Blue2 indicating a material severity of 2 and a societal severity of 2.

Fire limited to the room of origin which was fought using hose reels and resulted in damage to the room of origin, crews were in attendance for just under one hour and there was one person involved requiring a precautionary check up. The combined score for this incident was Yellow2 indicating a material severity factor of 3 and a societal severity factor of 2.



Fire limited to the floor of origin and resulting in damage to the floor of origin, fire fighters used CO2 and were in attendance for three quarters of an hour. There were no people involved. This incident has combined score of Yellow1 consisting of a material severity of 3 and a societal severity of 1.

### **1 - Slight**

Fire limited to the item first ignited and resulting in damage to the item first ignited, fire fighters were at the scene for 15 minutes and fire fighting action consisted of removal from the heat source. The householder had also attempted to remove from the heat source and sustained minor injuries requiring first aid at the scene. This incident resulted in a combined score of Green2, consisting of a material severity of 1 and a societal severity of 2.

Fire affecting the item first ignited but leading to damage to the room of origin, fire fighters were in attendance for 20 minutes and removed the item from the heat source. The householder disconnected the fuel supply prior to arrival but sustained no injuries or harm. The combined score for this incident was Blue1, made up of a material severity factor of 2 and a societal severity factor of 1.

Fire limited to the item first ignited and resulting in damage that is limited to the item first ignited, crews were in attendance for under quarter of an hour and no fire fighting was required as the householder had removed from the heat source prior to arrival. There were no casualties involved in this incident. This incident had a combined score of Green1, consisting of the minimum rating of 1 for both material and societal severity.

### Distribution of Incidents

Represented overleaf (see Fig 7) is the distribution using the severity matrix of the incident types taken over the period since IRS was first utilised (April 2009 to September 2011).

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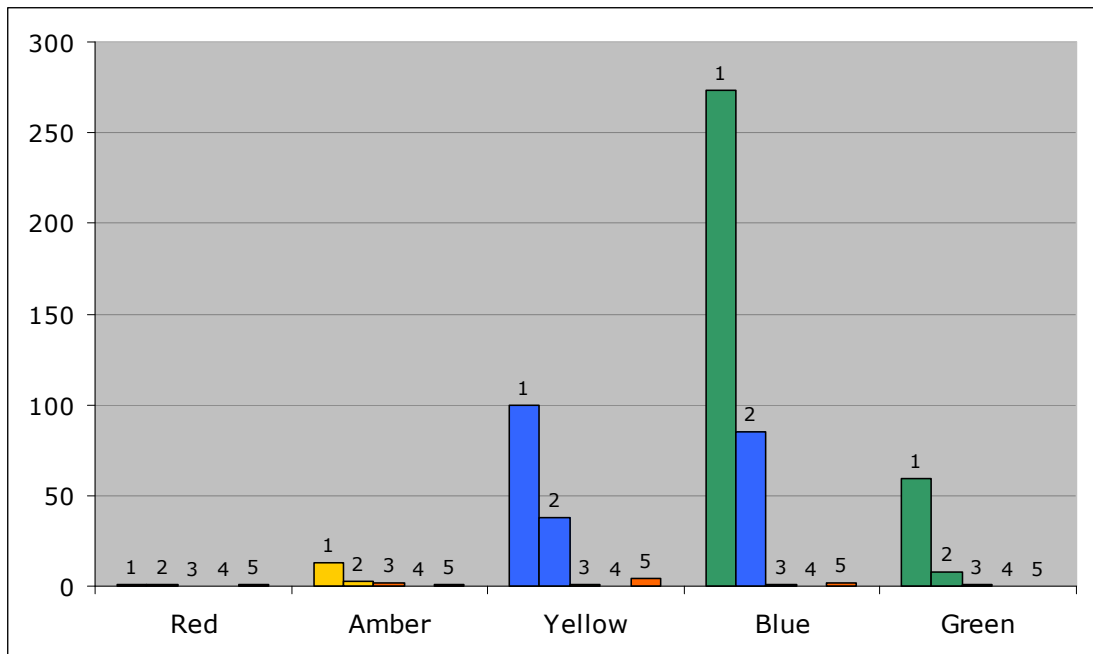


Fig 7

Finally, the chart below illustrates the overall distribution of each of the five combined categories using the simplified 1 – 5 scale. It is evident from this that the majority of incidents fall into the two lowest severity ratings: medium and slight. Furthermore as the severity ratings of the incidents increases, the frequency of their occurrence takes a sharp decline (see Fig 8).

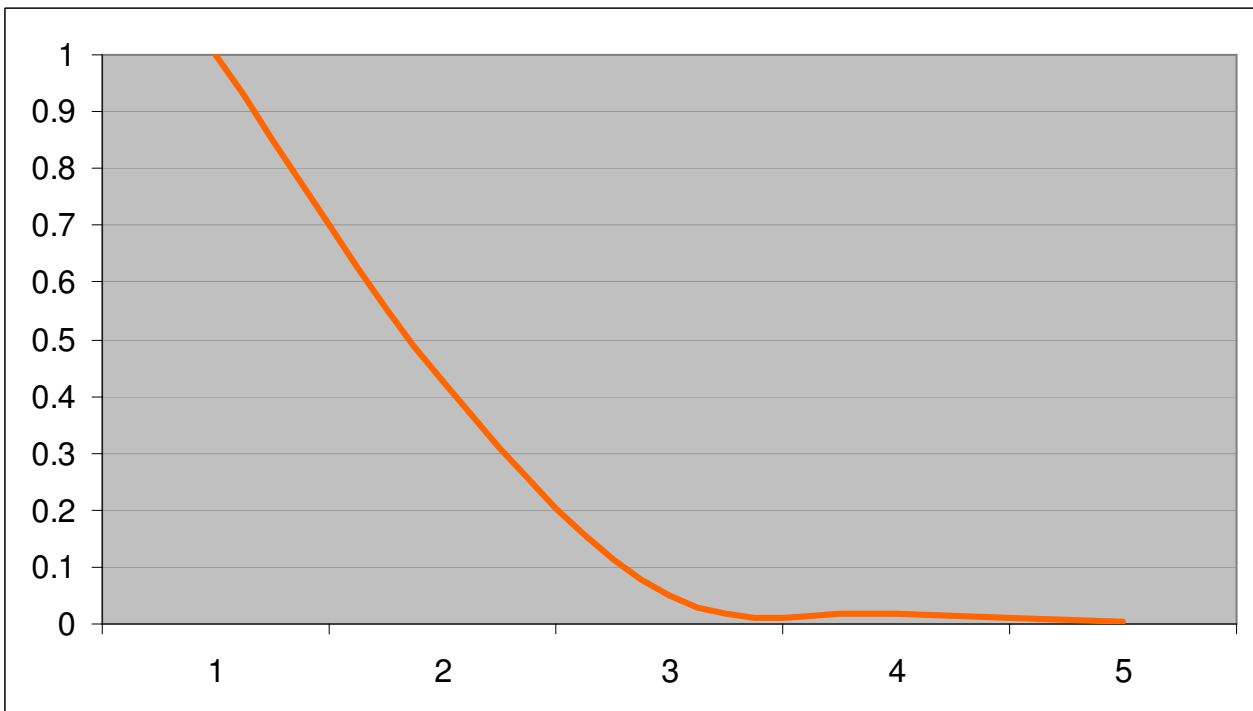


Fig 8

94% of all incidents fall into the 'Slight' or 'Moderate' categories as illustrated by the chart below (see Fig 9).

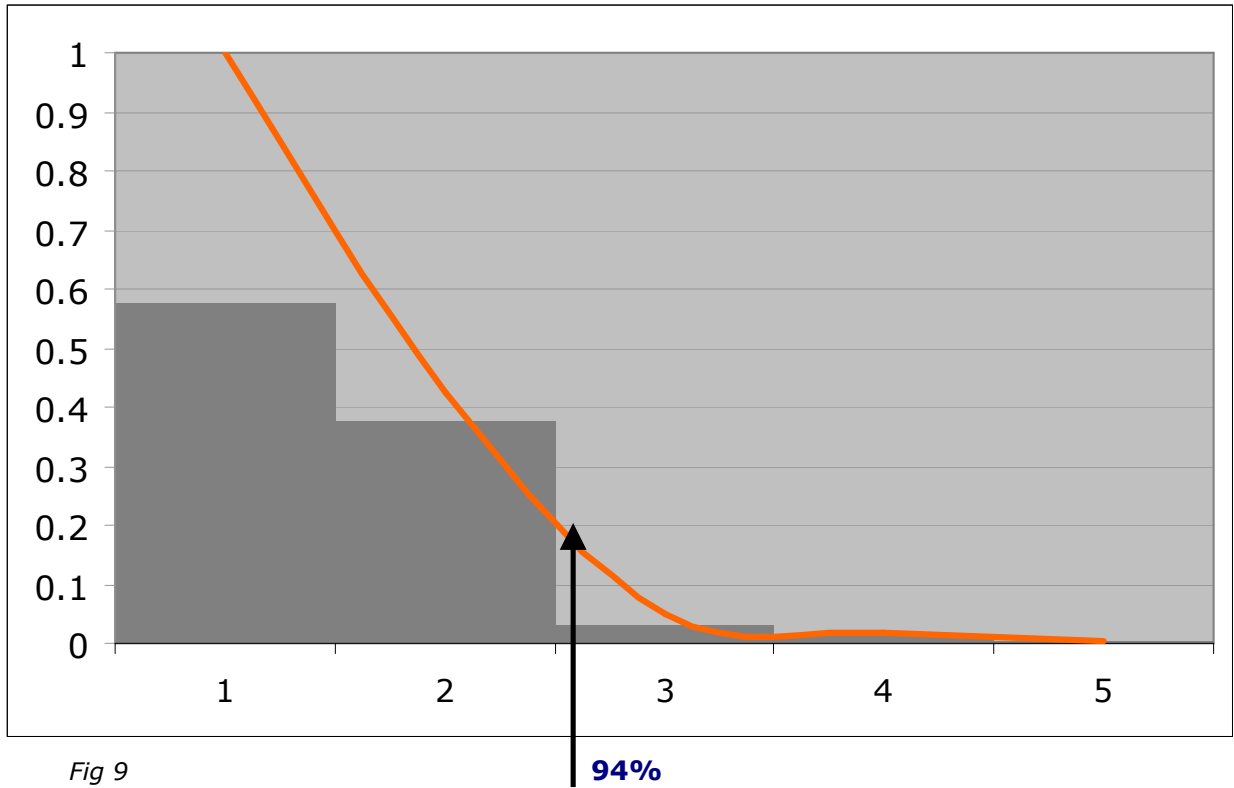
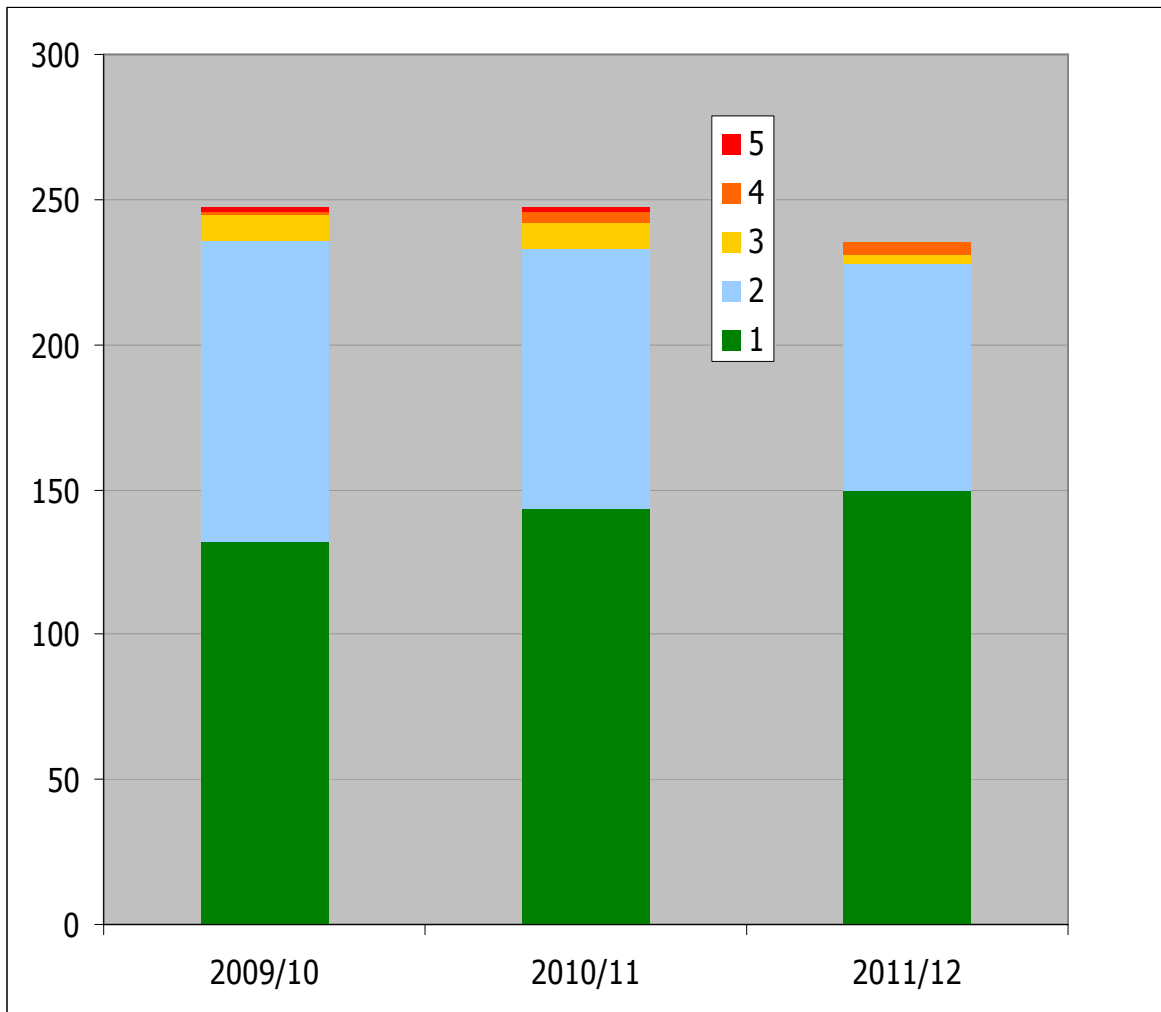


Fig 9

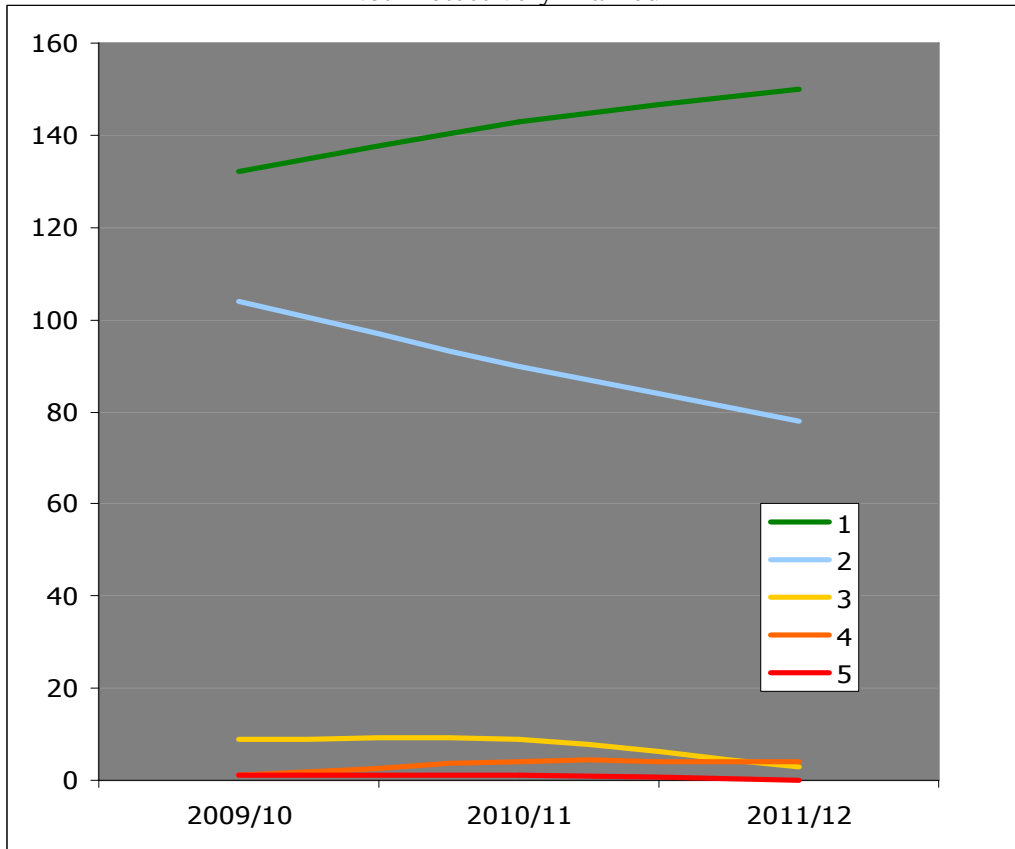
### Severity Analysis

Using the data available since the advent of IRS in 2009 (April 1 2009 to March 31 2012) analysis of the severity of incidents was carried out. As can be seen from the chart below, the number of accidental fires in dwellings is decreasing slightly but perhaps more significantly the same is true for the severity of these fires.



The same information can be seen on the line graph overleaf. Very severe, serious and moderate fires have all decreased whilst the number of severe fires has increased by a very small margin and the number of slight fires has increased fairly significantly. This would appear to indicate that some factor has lessened the affect of these fires. Therefore it is reasonable to make the assumption that this factor may be Community Safety intervention.

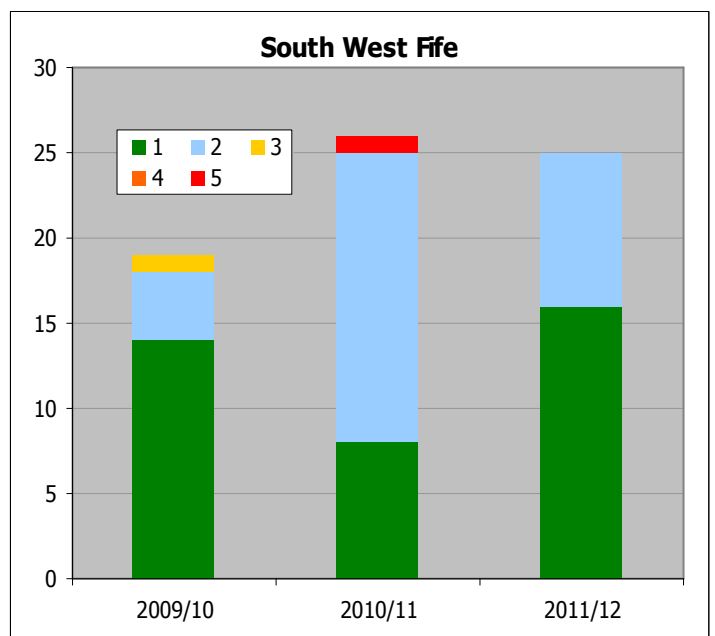
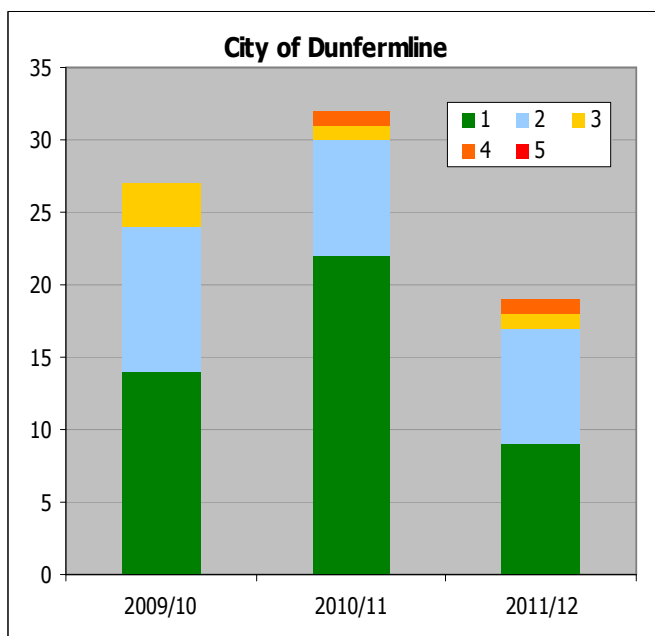
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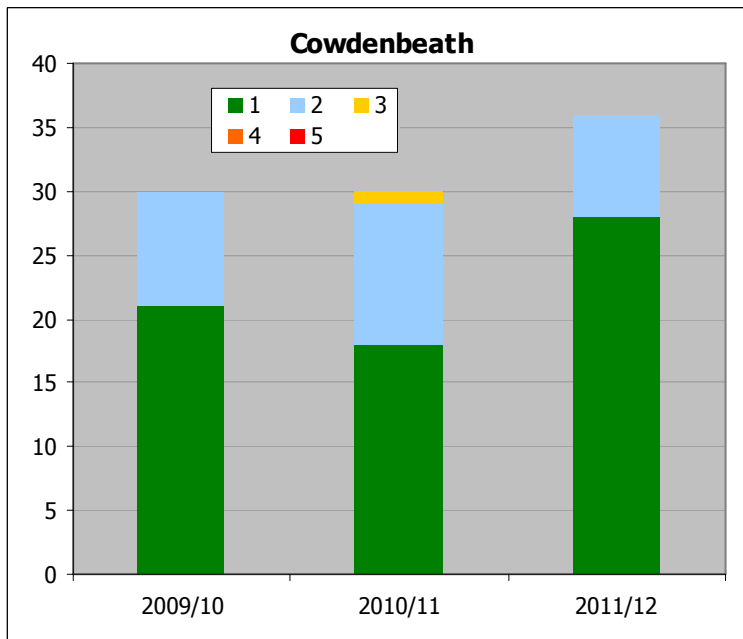
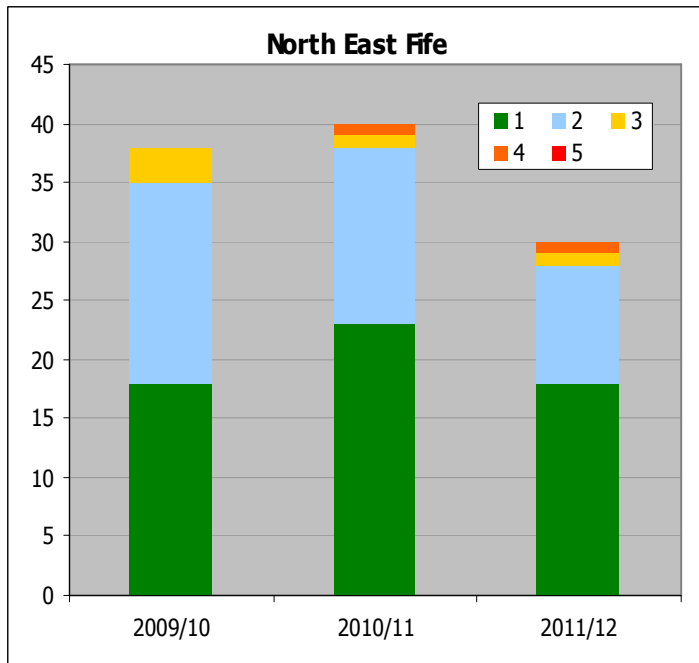
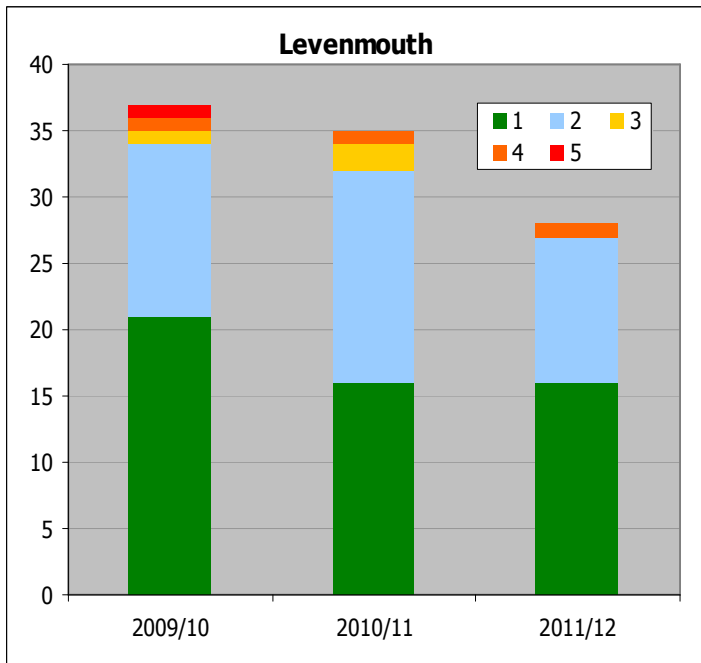
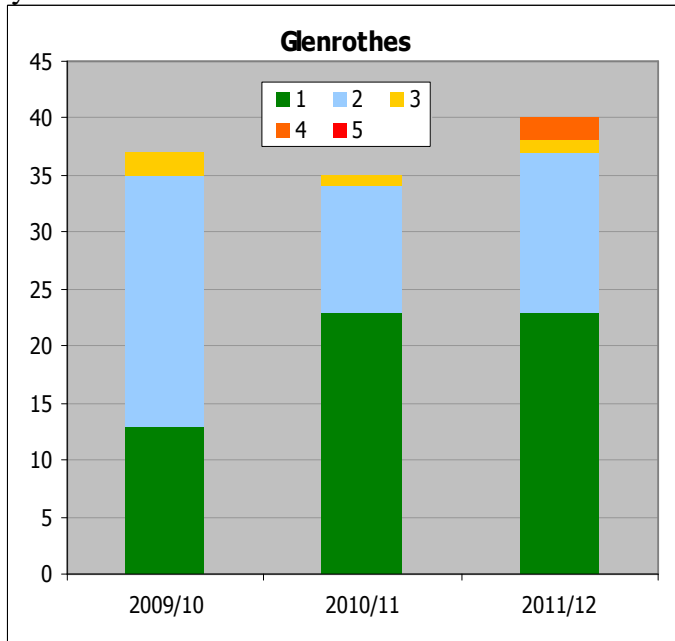
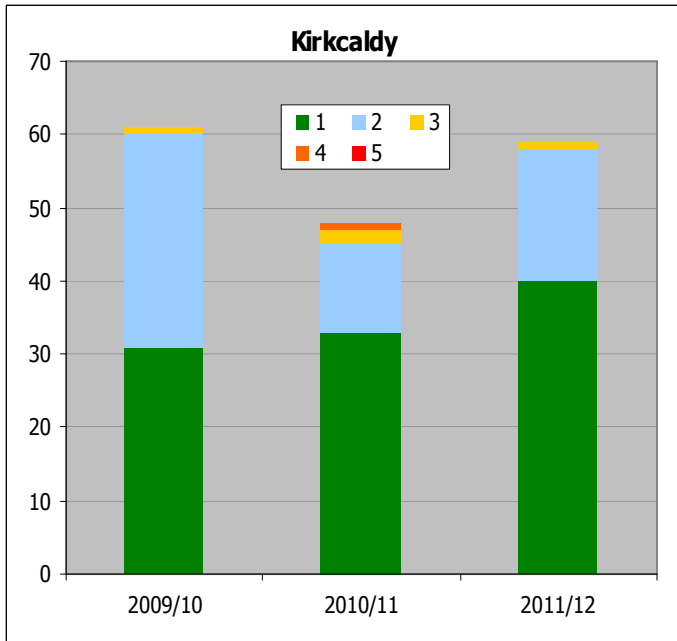
**Fife**

Looking at Fife overall, there has been a general decrease in both fires and severity of fires; however, there is a marked difference in the types of reductions over the Local Area Committees.

The following charts show the three years by area committee:

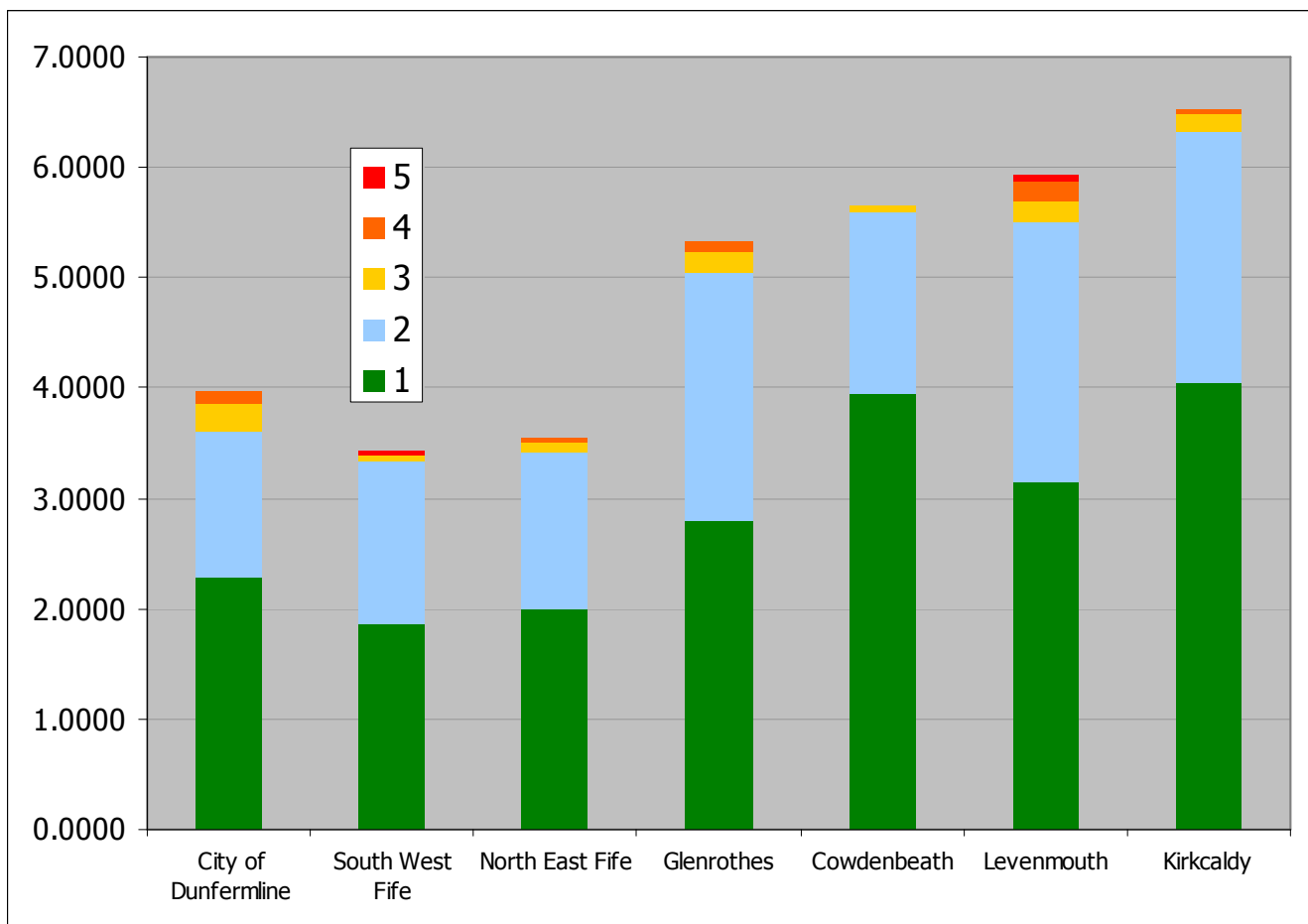


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The chart below shows all seven area committees over the 3 year period by severity and the ratings are calculated as a proportion of the total households within each area.

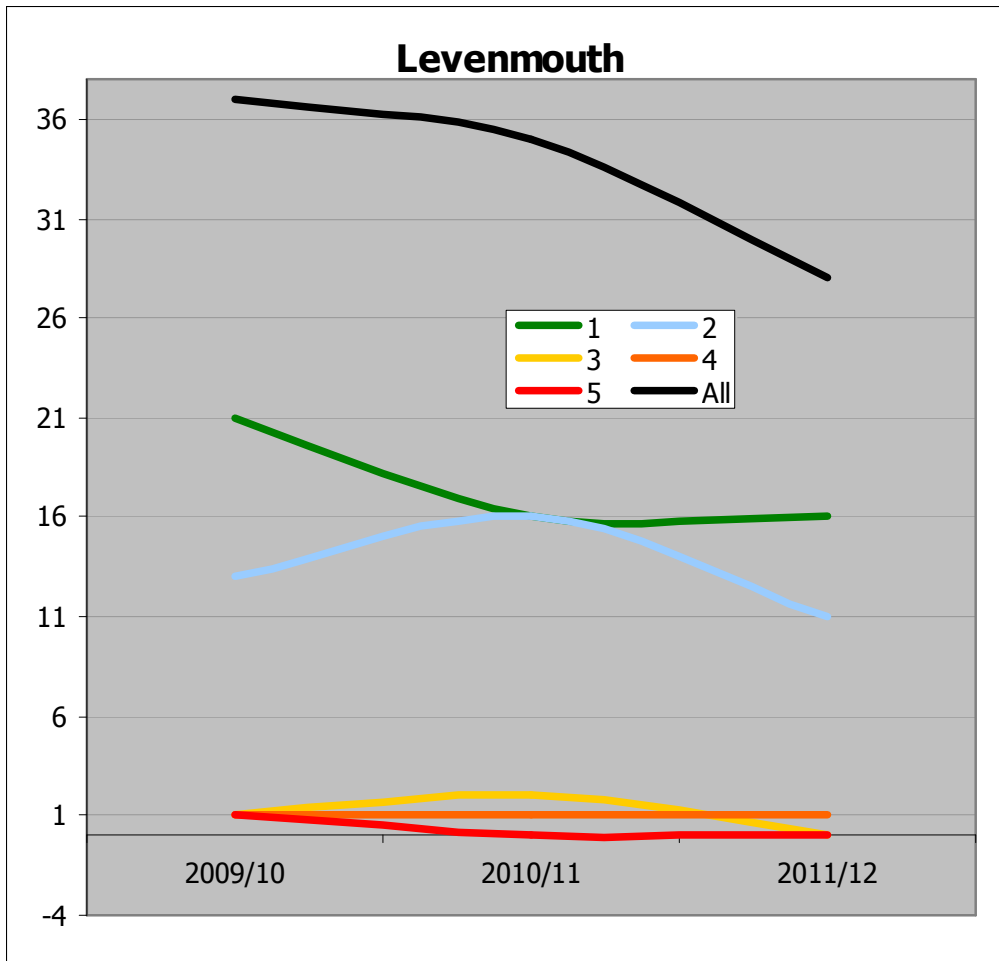


### CFS Activity

Methil Fire Station began a pilot scheme using the Mosaic Risk Areas that were recently developed in April 2010, under this system they have targeted all the (perceived by Mosaic) Above Average and Well Above Average risk areas and are now working through the Average areas.

Levenmouth Area Committee boundary is very similar to the Methil station boundary and it was therefore decided to focus on Levenmouth in order to see what, if any, impact the Mosaic targeting has had on severity.

The chart overleaf illustrates the changes in severity over the 3 year period. It would seem that there is a reduction in the number of accidental fires in dwellings generally but there is also a specific reduction in all severity levels except slight.



The following table further illustrates these facts and would perhaps suggest that there is a definite trend for the reduction of accidental fires in dwellings both overall and in severity.

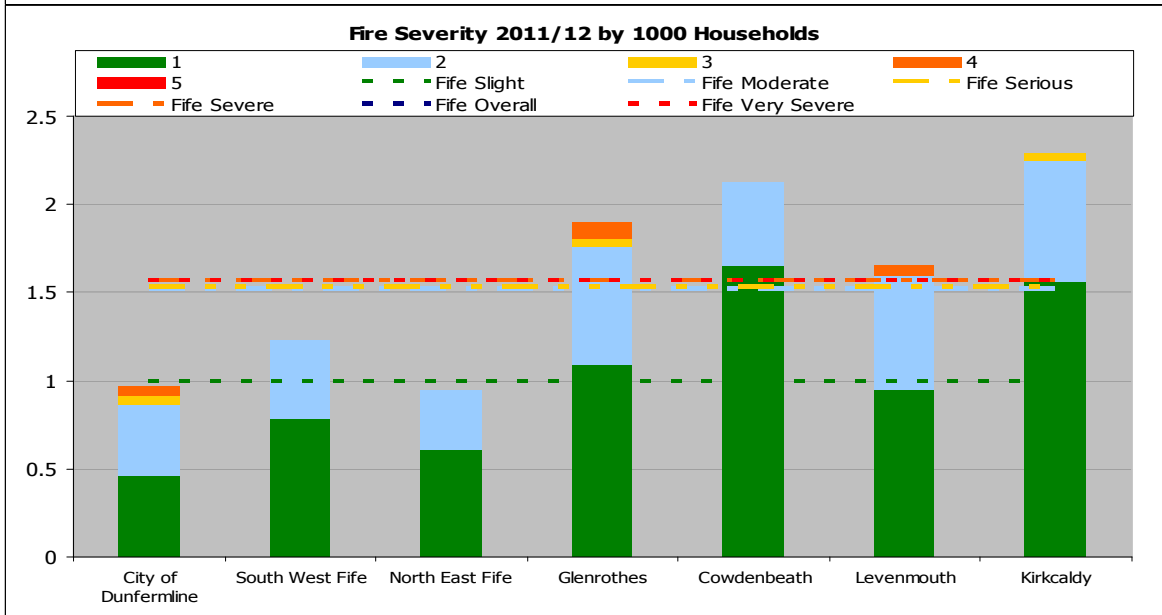
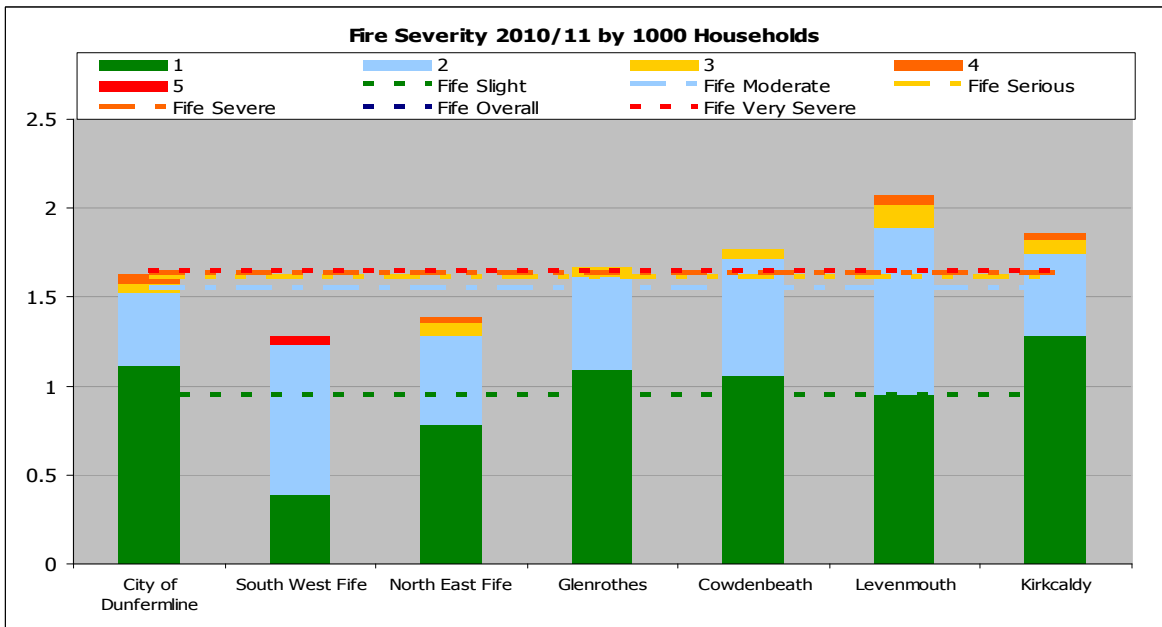
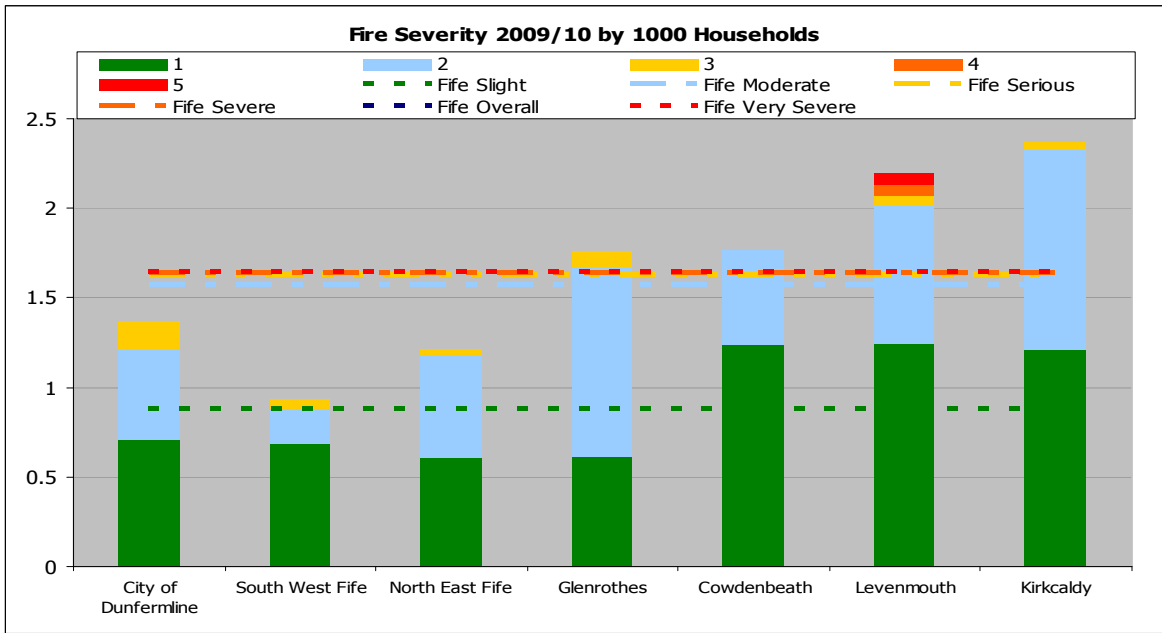
| Levenmouth      |         |         |         |       |
|-----------------|---------|---------|---------|-------|
| Severity Rating | 2009/10 | 2010/11 | 2011/12 | Total |
| 1               | 21      | 16      | 16      | 53    |
| 2               | 13      | 16      | 11      | 40    |
| 3               | 1       | 2       | 0       | 3     |
| 4               | 1       | 1       | 1       | 3     |
| 5               | 1       | 0       | 0       | 1     |
| All             | 37      | 35      | 28      | 100   |

Shown in conjunction with the other Area Committees, Levenmouth appears one of the most improved among them which would perhaps reinforce the proposition that Community Safety targeting of Mosaic Risk areas is proving to be a successful tool in the reduction of accidental fires in dwellings or their severity.

The three charts overleaf illustrate the above.



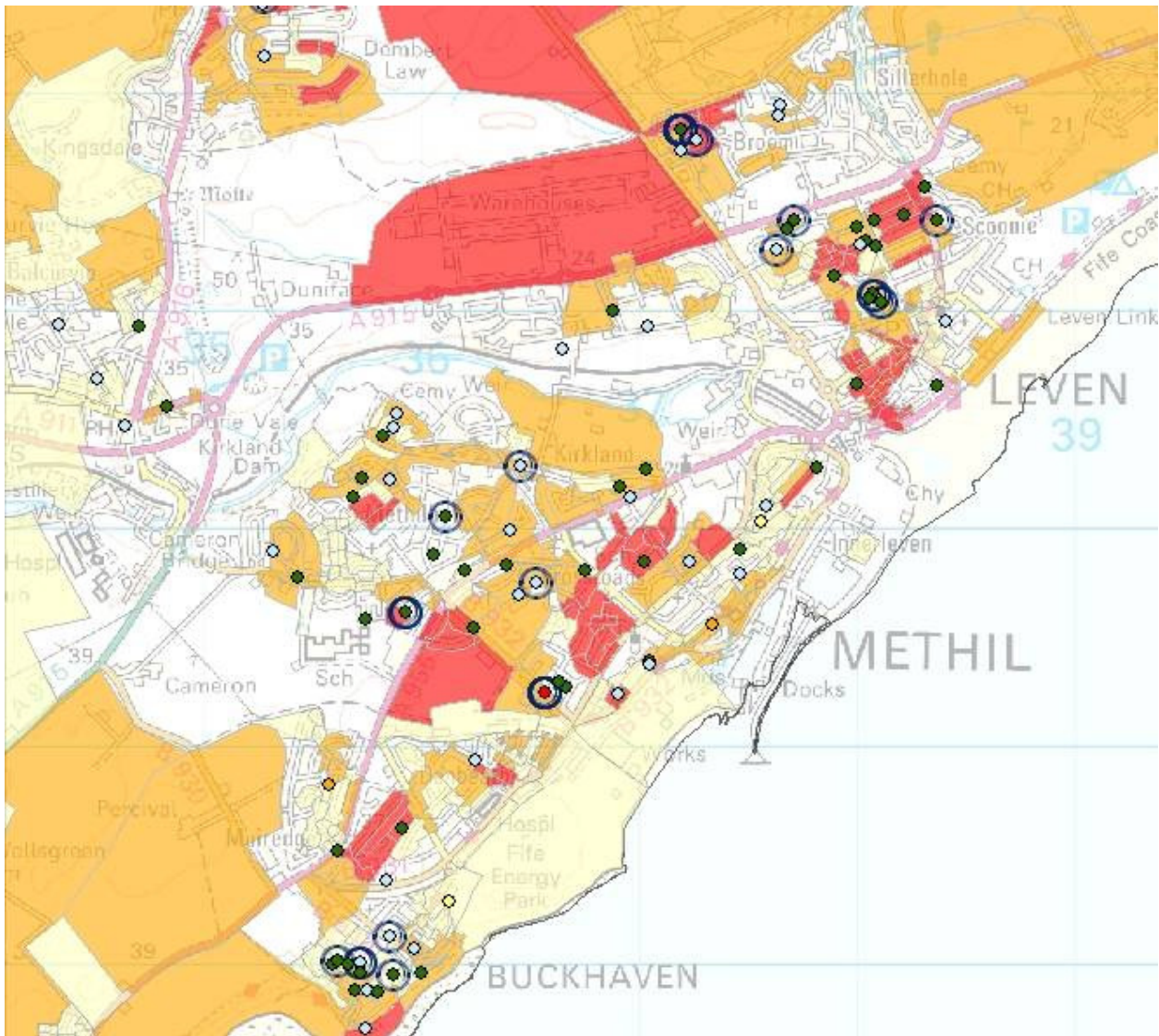
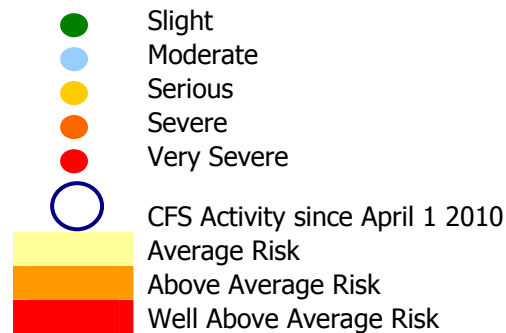
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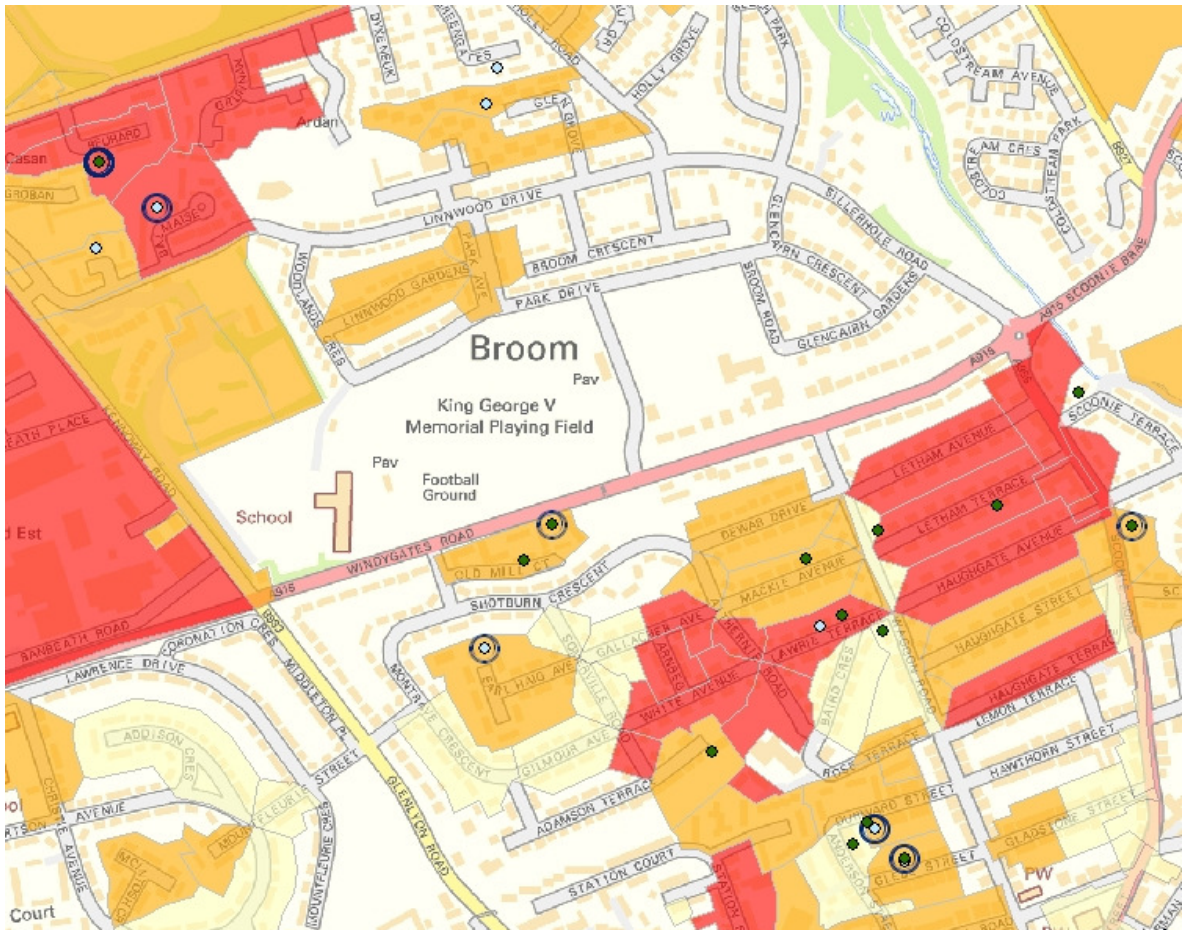
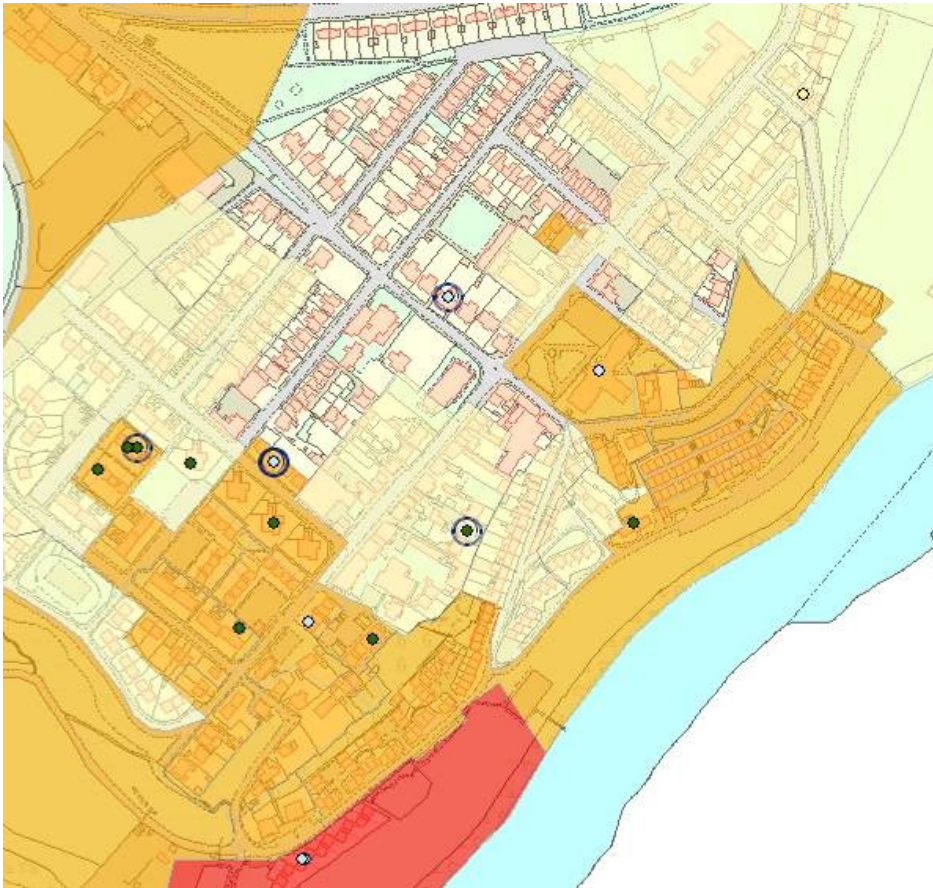
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Further examination of Community Fire Safety activity in the Levenmouth area shows that there is a concentration of activity and incidents within the higher Mosaic risk areas. There have been visits prior to several less severe incidents occurring and the assumption can therefore be made that without the visit and/or alarm being fitted the incident may have resulted in one more severe.

The maps below indicate incidents (by severity) over the last 3 years and 3 months along with the higher risk Mosaic areas and the CFS activities that occurred in the same households as the incidents.



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