In [1]:
```
import os
import tensorflow as tf
import numpy as np
from keras.applications import ResNet50
from efficientnet.tfkeras import EfficientNetB4
from keras.models import Sequential, Model
from keras.layers import Input, Conv2D, MaxPooling2D, Dropout, Flatten, Dense, BatchN
from keras import regularizers
from keras.optimizers import Adam
from keras.callbacks import ModelCheckpoint, EarlyStopping
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from keras.utils import plot_model
import matplotlib.pyplot as plt
from sklearn.metrics import confusion_matrix, f1_score, classification_report, accura
import seaborn as sns
from IPython.display import Image
import warnings
os.environ['TF_CPP_MIN_LOG_LEVEL'] = '2'
warnings.filterwarnings('ignore', category=UserWarning)
```

In [2]:
```
from PIL import ImageFile
ImageFile.LOAD_TRUNCATED_IMAGES = True
```

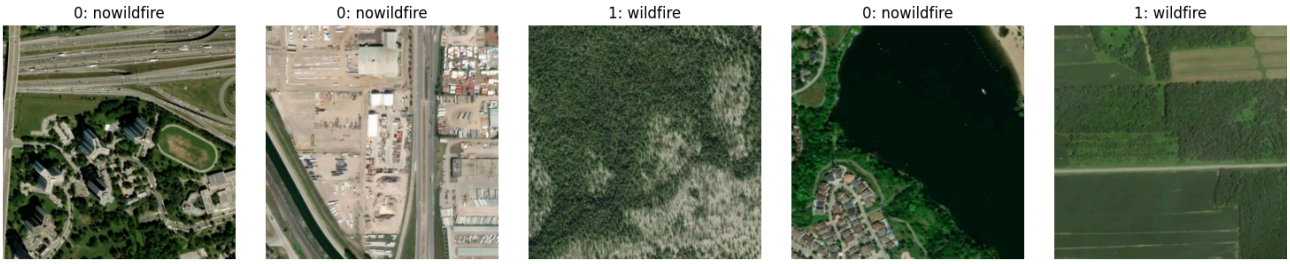
In [3]:
```
train_path = "./wildfire-dataset/train"
valid_path = "./wildfire-dataset/valid"
test_path = "./wildfire-dataset/test"
```

In [4]:
```
train_datagen = ImageDataGenerator(rescale=1./255)
valid_datagen = ImageDataGenerator(rescale=1./255)
test_datagen = ImageDataGenerator(rescale=1./255)

train_generator = train_datagen.flow_from_directory(
    train_path,
    target_size=(350, 350),
    batch_size=32,
    class_mode='binary',
    shuffle=True)

valid_generator = valid_datagen.flow_from_directory(
    valid_path,
    target_size=(350, 350),
    batch_size=32,
    class_mode='binary',
    shuffle=True)

test_generator = test_datagen.flow_from_directory(
    test_path,
    target_size=(350, 350),
    batch_size=32,
    class_mode='binary',
    shuffle=False)
```

```
Found 30250 images belonging to 2 classes.
Found 6300 images belonging to 2 classes.
Found 6300 images belonging to 2 classes.
```

In [5]:
```
def display_images_from_generator(generator, num_images=5):
    x_batch, y_batch = next(generator)

    plt.figure(figsize=(num_images * 3, 3))
    for i in range(num_images):
        plt.subplot(1, num_images, i+1)
        plt.imshow(x_batch[i])
        label = "1: wildfire" if y_batch[i] > 0.5 else "0: nowildfire"
        plt.title(label, fontsize=12)
        plt.axis('off')
    plt.tight_layout()
    plt.show()
```

In [6]:
```
display_images_from_generator(train_generator)
```



In [7]:
```
display_images_from_generator(valid_generator)
```

In [8]:
```
display_images_from_generator(test_generator)
```

In [9]:
```
def resnet50(input_shape=(350, 350, 3), num_classes=1):
    base_model = ResNet50(weights='imagenet', include_top=False, input_shape=input_sha

    for layer in base_model.layers[:-4]:
        layer.trainable = False

    x = base_model.output
    x = GlobalAveragePooling2D()(x)
    x = Dense(1024, activation='relu')(x)
    predictions = Dense(num_classes, activation='sigmoid')(x)

    model = Model(inputs=base_model.input, outputs=predictions)
    model.compile(optimizer=Adam(), loss='binary_crossentropy', metrics=['accuracy'])
    model.name = 'ResNet50'

    return model
```

In [10]:
```
model=resnet50()
```

In [11]:
```
model.summary()
```

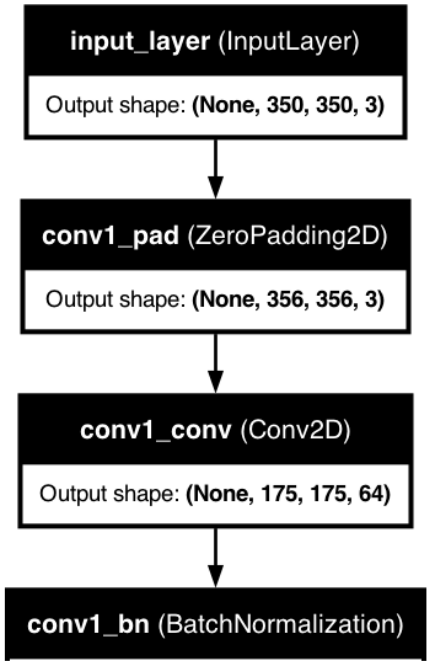
(BatchNormalizatio…	2048)		
conv5_block3_add (Add)	(None, 11, 11, 2048)	0	conv5_block2_out… conv5_block3_3_b…
conv5_block3_out (Activation)	(None, 11, 11, 2048)	0	conv5_block3_add…
global_average_poo… (GlobalAveragePool…	(None, 2048)	0	conv5_block3_out…
dense (Dense)	(None, 1024)	2,098,176	global_average_p…
dense_1 (Dense)	(None, 1)	1,025	dense[0][0]

Total params: 25,686,913 (97.99 MB)

Trainable params: 3,153,921 (12.03 MB)

In [12]:
```
plot_model(model, to_file=f'{model.name}_model.png', show_shapes=True, show_layer_name
Image(filename=f'{model.name}_model.png')
```

Out[12]:



In [13]:

```
%%time
checkpointer = ModelCheckpoint(f'{model.name}.weights.h5', verbose=1, save_best_only=
early_stopping = EarlyStopping(monitor='val_loss', patience=10)

history = model.fit(
    train_generator,
    epochs=10,
    verbose=1,
    validation_data=valid_generator,
    callbacks=[checkpointer, early_stopping]
)
```

```
Epoch 1/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 684ms/step - accuracy: 0.8574 - loss: 0.3748
Epoch 1: val_loss improved from inf to 0.54970, saving model to ResNet50.weights.h5
946/946 ━━━━━━━━━━━━━━━━━━━━ 787s 826ms/step - accuracy: 0.8574 - loss: 0.3747 - val
_accuracy: 0.7324 - val_loss: 0.5497
Epoch 2/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 708ms/step - accuracy: 0.9038 - loss: 0.2473
Epoch 2: val_loss did not improve from 0.54970
946/946 ━━━━━━━━━━━━━━━━━━━━ 808s 853ms/step - accuracy: 0.9038 - loss: 0.2473 - val
_accuracy: 0.4484 - val_loss: 1.5135
Epoch 3/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 735ms/step - accuracy: 0.9118 - loss: 0.2269
Epoch 3: val_loss improved from 0.54970 to 0.20246, saving model to ResNet50.weight
s.h5
946/946 ━━━━━━━━━━━━━━━━━━━━ 837s 885ms/step - accuracy: 0.9118 - loss: 0.2269 - val
_accuracy: 0.9241 - val_loss: 0.2025
Epoch 4/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 738ms/step - accuracy: 0.9159 - loss: 0.2237
Epoch 4: val_loss did not improve from 0.20246
946/946 ━━━━━━━━━━━━━━━━━━━━ 837s 885ms/step - accuracy: 0.9159 - loss: 0.2237 - val
_accuracy: 0.8813 - val_loss: 0.2568
Epoch 5/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 744ms/step - accuracy: 0.9154 - loss: 0.2148
Epoch 5: val_loss did not improve from 0.20246
946/946 ━━━━━━━━━━━━━━━━━━━━ 845s 893ms/step - accuracy: 0.9155 - loss: 0.2148 - val
_accuracy: 0.5030 - val_loss: 1.2729
Epoch 6/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 754ms/step - accuracy: 0.9173 - loss: 0.2116
Epoch 6: val_loss did not improve from 0.20246
946/946 ━━━━━━━━━━━━━━━━━━━━ 858s 907ms/step - accuracy: 0.9173 - loss: 0.2116 - val
_accuracy: 0.8570 - val_loss: 0.3427
Epoch 7/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 769ms/step - accuracy: 0.9223 - loss: 0.2043
Epoch 7: val_loss did not improve from 0.20246
946/946 ━━━━━━━━━━━━━━━━━━━━ 862s 910ms/step - accuracy: 0.9223 - loss: 0.2043 - val
_accuracy: 0.8851 - val_loss: 0.2585
Epoch 8/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 734ms/step - accuracy: 0.9258 - loss: 0.1938
Epoch 8: val_loss improved from 0.20246 to 0.19862, saving model to ResNet50.weight
s.h5
946/946 ━━━━━━━━━━━━━━━━━━━━ 838s 885ms/step - accuracy: 0.9258 - loss: 0.1938 - val
_accuracy: 0.9273 - val_loss: 0.1986
Epoch 9/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 733ms/step - accuracy: 0.9286 - loss: 0.1873
Epoch 9: val_loss did not improve from 0.19862
946/946 ━━━━━━━━━━━━━━━━━━━━ 843s 891ms/step - accuracy: 0.9286 - loss: 0.1873 - val
_accuracy: 0.6222 - val_loss: 0.8002
Epoch 10/10
946/946 ━━━━━━━━━━━━━━━━━━━━ 0s 742ms/step - accuracy: 0.9269 - loss: 0.1841
Epoch 10: val_loss did not improve from 0.19862
946/946 ━━━━━━━━━━━━━━━━━━━━ 841s 889ms/step - accuracy: 0.9269 - loss: 0.1841 - val
_accuracy: 0.9111 - val_loss: 0.2393
CPU times: user 15min 22s, sys: 13min 52s, total: 29min 14s
Wall time: 2h 19min 16s
```

In [14]:
```
def display_images_with_predictions_from_generator(generator, model, num_wildfire=2, 
    wildfire_pool = []
    nowildfire_pool = []

    while len(wildfire_pool) < num_wildfire or len(nowildfire_pool) < num_nowildfire:
        x_batch, y_batch = next(generator)
        for i in range(len(y_batch)):
            if y_batch[i] > 0.5:  # Wildfire
                wildfire_pool.append((x_batch[i], y_batch[i]))
            else:  # No Wildfire
                nowildfire_pool.append((x_batch[i], y_batch[i]))

    np.random.seed(10)
    selected_wildfire = np.random.choice(range(len(wildfire_pool)), size=num_wildfire
    selected_nowildfire = np.random.choice(range(len(nowildfire_pool)), size=num_nowi

    selected_images = [wildfire_pool[i][0] for i in selected_wildfire] + [nowildfire_
    selected_labels = [wildfire_pool[i][1] for i in selected_wildfire] + [nowildfire_

    predictions = model.predict(np.array(selected_images)).flatten()

    plt.figure(figsize=(len(selected_images) * 3, 3))
    for i in range(len(selected_images)):
        plt.subplot(1, len(selected_images), i + 1)
        plt.imshow(selected_images[i])
        true_label = "Wildfire" if selected_labels[i] > 0.5 else "No Wildfire"
        predicted_label = "Wildfire" if predictions[i] > 0.5 else "No Wildfire"
        plt.title(f"True: {true_label}\nPred: {predicted_label}")
        plt.axis('off')
    plt.tight_layout()
    plt.show()
```

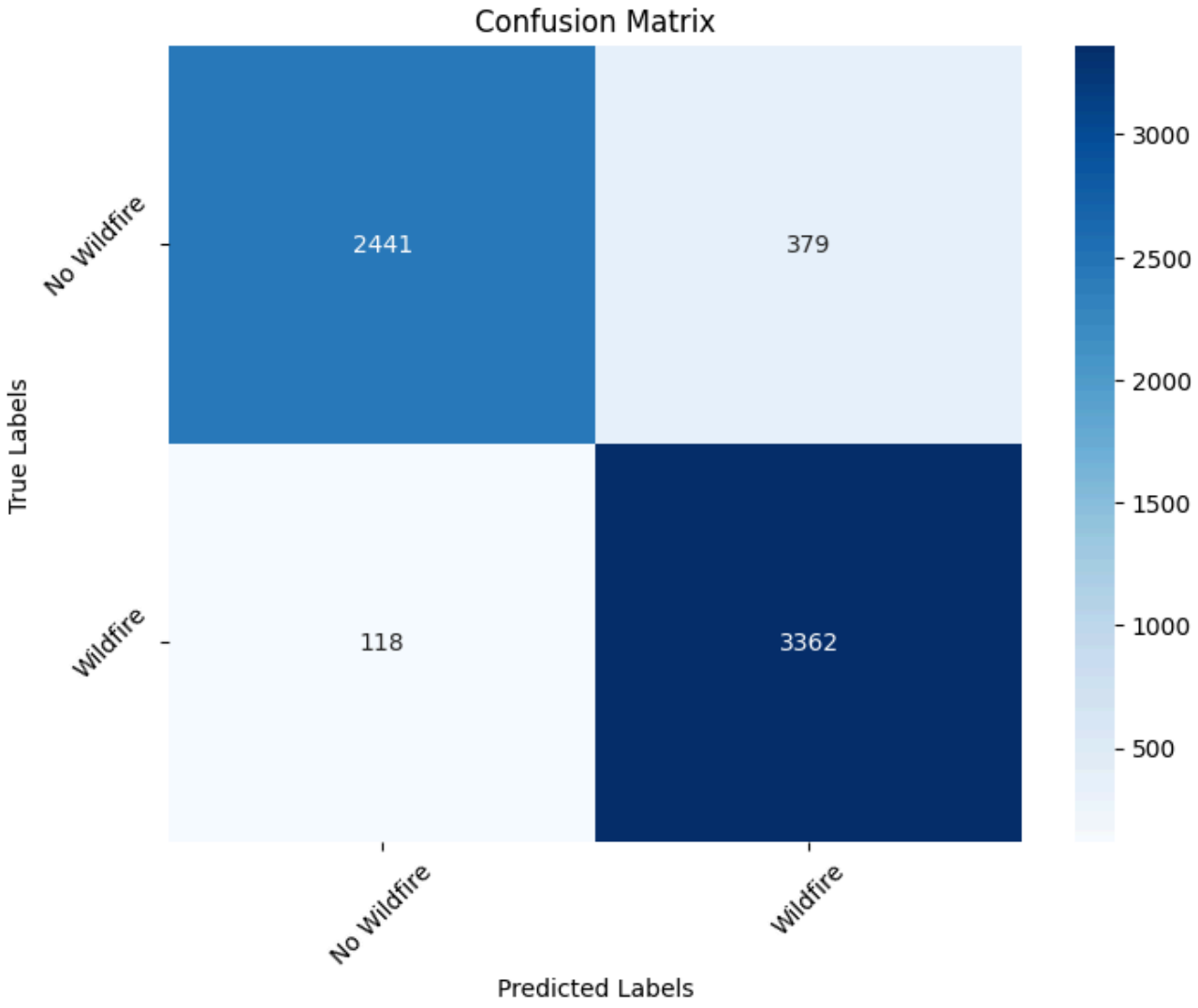
In [15]:
```
display_images_with_predictions_from_generator(test_generator, model)
```

```
1/1 ━━━━━━━━━━━━━━━━━━━━ 2s 2s/step
```

In [16]:
```
def plot_confusion_matrix_and_metrics(generator, model):
    label_names = ['No Wildfire', 'Wildfire']
    # Step 1: Calculate metrics and prepare the data
    y_true = generator.classes
    y_pred = model.predict(generator)
    y_pred = (y_pred > 0.5).astype(int)

    # Confusion matrix visualization
    conf_mat = confusion_matrix(y_true, y_pred)
    plt.figure(figsize=(8, 6))
    sns.heatmap(conf_mat, annot=True, fmt='d', cmap='Blues')
    plt.title('Confusion Matrix')
    plt.xlabel('Predicted Labels')
    plt.ylabel('True Labels')
    plt.xticks(ticks=np.arange(len(label_names)) + 0.5, labels=label_names, rotation=
    plt.yticks(ticks=np.arange(len(label_names)) + 0.5, labels=label_names, rotation=
    plt.show()

    # Classification Report in text
    report_text = classification_report(y_true, y_pred, target_names=label_names)
    print(report_text)

    # Print F1 score
    f1 = f1_score(y_true, y_pred)
    print(f"F1 Score: {f1:.2f}")

    # Print accuracy in percentage
    accuracy = accuracy_score(y_true, y_pred)
    print(f"Accuracy: {accuracy * 100:.2f}%")
```

In [17]:
```
plot_confusion_matrix_and_metrics(test_generator, model)
```

```
197/197 ━━━━━━━━━━━━━━━━━━━━ 137s 685ms/step
```



	precision	recall	f1-score	support
No Wildfire	0.95	0.87	0.91	2820
Wildfire	0.90	0.97	0.93	3480
accuracy			0.92	6300
macro avg	0.93	0.92	0.92	6300
weighted avg	0.92	0.92	0.92	6300

```
F1 Score: 0.93
Accuracy: 92.11%
```

In [18]:
```python
def plot_training_history(history):
    plt.figure(figsize=(16, 6))

    epochs = range(1, len(history.history['accuracy']) + 1)

    plt.subplot(1, 2, 1)
    plt.plot(epochs, history.history['accuracy'], label='Train Accuracy', marker='o')
    plt.plot(epochs, history.history['val_accuracy'], label='Validation Accuracy', mar
    plt.title('Model Training and Validation Accuracy')
    plt.xlabel('Epoch')
    plt.ylabel('Accuracy')
    plt.xticks(epochs)
    plt.legend()

    plt.subplot(1, 2, 2)
    plt.plot(epochs, history.history['loss'], label='Train Loss', marker='o')
    plt.plot(epochs, history.history['val_loss'], label='Validation Loss', marker='o'
    plt.title('Model Training and Validation Loss')
    plt.xlabel('Epoch')
    plt.ylabel('Loss')
    plt.xticks(epochs)
    plt.legend()

    plt.tight_layout()
    plt.savefig(f'{model.name}_training_history.png', dpi=300)
    plt.show()
```

In [19]:
```python
plot_training_history(history)
```